Aquatic Monitoring Plan and Assessment Summary for Streams in the Tintina Black Butte Copper Project Area of Meagher County, MT 2014-2019

Prepared for:

Tintina Montana, Inc.
White Sulphur Springs, Montana 59645

Sheep Creek SH18.3 in November 2019-Last Redd Count Visit before freeze-up.

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ACRONYMS

AFDW	Ash Free Dry Weight
AMP	Aquatic Monitoring Plan
ANOVA	Analysis of variance
AU	Assessment Unit
BBC	Black Butte Copper project area
cfs	Cubic feet per second
CHL-a	Chlorophyll a biomass
CN	Coon Creek
DEQ	Department of Environmental Quality (Montana)
DO	Dissolved Oxygen
DQA	Data Quality Assessment
EBT	Brook Trout
EPA	Environmental Protection Agency (US)
EPT	Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa
FAS	Fishing access site
HBI	Hilsenhoff Biotic Index

HUC	Hydrologic Unit Code
LOLE	Brown Trout
LS	Little Sheep Creek
MFWP	Montana Fish Wildlife and Parks
m	meter
mm	millimeter
MMI	Multi-metric macroinvertebrate
MOWF	Mountain whitefish
MSU	Montana State University
NHD	National Hydrography Data (set)
PFC	Proper functioning condition
QA	Quality Assurance
QC	Quality Control
RBT	Rainbow Trout
RMCOT	Rocky Mountain Sculpin
SCD	Sufficient Credible Data
SE	Standard error of the sample
SH	Sheep Creek
SOC	Species of Concern
SW	Surface Water Quality Monitoring Site
TMDL	Total Maximum Daily Load
TN	Tenderfoot Creek
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCT	Westslope Cutthroat Trout
WEPE	Western pearlshell mussel

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All photos in the report were taken by MBS personnel, unless otherwise noted

Executive Summary

We have completed the 5th year of aquatic baseline surveys and the 2nd year of implementing the full Tintina Black Butte Copper Aquatic Monitoring Plan (BBC AMP 2017) for the assessment of fish, macroinvertebrates, periphyton, Chl-*a* and stream habitat at sites in the Sheep Creek drainage basin with Tenderfoot and Moose Creeks as reference streams. These 2014-2019 data represent reach-scale stream and aquatic community conditions documented to exist prior to any proposed mine activity (i.e. pre-impact). Project goals are: 1) to conduct, repeatable standardized surveys to collect baseline data on the aquatic communities in accordance with the BBC AMP (2017), 2) to monitor fish populations and seasonal use of Sheep Creek and its tributaries near the BBC project area, and 3) to assess aquatic integrity with biotic indicators within thresholds of reference condition standards to determine trends and natural variability.
Habitat assessments and macroinvertebrate, periphyton, and fish surveys were performed on the 12 stream reaches of Sheep, Little Sheep and Tenderfoot Creeks on slightly later dates (7-10 days delayed) in 2019 than in 2014-2018. This was due to sustained high run-off flows and large rain events in early-July.

One additional lower Sheep Creek (River Mile 0.1) and two Smith River bug monitoring sites were added in 2018: ~15 miles downstream of the previous lowest impact site. The Moose Creek (MO.1) site fish surveys and redd counts have occurred since fall of 2017. This sampling design uses a 'BACI' approach: Before, After, and Control sample sites both upstream and off-project site locations; Impact sites were located both within and up to ~18.5 miles downstream of proposed mine activity (Smith River d/s of Sheep Creek).

In total, 12 established monitoring stream reaches were sampled between 2014 and 2019 with 96 seasonal fish survey events: 170 macroinvertebrate and 49 periphyton samples. All stream reaches were visually inspected for amphibians, and physical water quality parameters (temp., TDS, pH, conductivity) were recorded before the aquatic surveys. Biological community integrity was evaluated for the reaches using assessment metrics known to be affected by water quality, quantity and stream habitat conditions; metrics from Montana DEQ's multi-metric macroinvertebrate (MMI), Sediment Assessment Protocols, and periphyton Trophic Diatom Indices (TDI).

Habitat / Water Quality Evaluations. It is important to document baseline water quality and stream habitat conditions in the project area prior to any developments. Water quality sampling has been conducted quarterly at four aquatic monitoring sites by Hydrometrics, Inc. since the spring of 2011. Stream macro-habitats have been mapped for all reaches and are dominated by riffle and runs; Sheep Creek avg. 80 percent (%), Little Sheep 73%, Moose 84% and Tenderfoot Creek 75% of total stream reach length. Of the 12 long-term sampling reaches evaluated in the study area, 6 were found in Proper Functioning Condition (PFC) with a stable trend, and 6 were deemed Functional-at-Risk (FAR). Sites were ranked FAR because they either had riparian habitat altered by cattle at Little Sheep Creek (LS) sites LS.1 and LS.7; Sheep Creek (SH) sites SH22.7 and SH15.5U, MO.1, and Tenderfoot Creek (TN) site TN9.3, or by human stream manipulation at sites SH17.5 and SH22.7. Highest site habitat integrity scores were recorded at the upper (SH19.2) and lower (SH18.3) meadow reaches, Coon Creek (CN) site CN.5 and TN9.4. It is important to note that the

pre-existing riparian condition of the lower reference reach on Tenderfoot Creek (TN9.3) and the control site on Sheep Creek (SH22.7) are moderately degraded. Sheep Creek impacted sites downstream of the U.S. Forest Service (USFS) canyon (SH17.5, SH15.5U and SH15.5D) had overall higher % silt in the riffle and pool grid tosses, but this decreased significantly (T-test, p=0.03) between 2018 and 2019 with higher stream flows.

Fish Communities. Overall, we identified 9 fish species and 1 hybrid (6 native and 4 introduced) from ~15,000 individuals collected at 11 sites during 96 seasonal stream reach surveys between 2014 and 2019. Average number of fish species per site was 5.6 (± 0.47 standard error [SE]), while the average number of native species averaged 2 (± 0.4 SE). This is an increase from 3.6 total species per site in 2014-2015 due to longer survey lengths, and the increased detection of mountain whitefish (MOWF), longnose dace (LNDA) and white suckers (WHSU) at multiple sites.

Rocky mountain sculpin (RMCOT) comprised the highest proportion of total fish collected (71%) and had 100% site occupancy (n=11). Other native species, MOWF, LNDA and WHSU had site occupancy rates of 64%, 45% and 55%, respectively.

Rainbow trout (RBT) were the dominant salmonid by numbers at all Sheep, Moose and Tenderfoot Creek sites, except in the meadow reaches, SH19.2 and SH18.3, where brown trout (LOLE) and MOWF were dominant, respectively. RBT and brook trout (EBT) were collected at 10 of 11 sites in total, achieving highest average estimated densities at Moose Creek site MO.1 (879 per mile ± 646 SE) and Little Sheep site LS.1 (847 per mile ± 178 SE), respectively. LOLE were collected at 8 of 11 sites, achieving highest densities at sites SH19.2 and SH18.3 averaging ~95 per mile ± 28 SE. The most diverse fish sites in the study area are sites SH15.5U/D and SH19.2 with eight species, four of these native. Coon Creek site C.5, upstream of the county road near SW3, was determined to be fishless in 2015, but near its confluence with Sheep Creek, it provides a refuge for young-of-the-year brown and brook trout.

No pure westslope cutthroat trout (WCT), a Montana Species of Concern (SOC), have been identified during any of the surveys of Little Sheep, Sheep or Moose Creeks. Although, CTxRBT hybrids were occasionally collected at sites SH22.7, SH19.2, SH17.5, SH15.5U/D; these were not tested genetically, but phenotypically appear less than 90% pure WCT. In 2016, we documented WHSUs and MOWF juveniles using LS.1. In 2017, we reported the first collection of a mountain sucker (MOSU) (n=1) at the impact site SH15.5D but have not observed this species in 2018 or 2019. Mark-recapture fish population estimates in 2018 were very comparable to previous years' 2-pass depletion estimates across the Sheep Creek sites, except at SH15.5U which exhibited a significant increase in RBT numbers in 2018, likely from an out-migration of juveniles from Moose Creek.

Salmonid densities varied significantly annually and seasonally across most sites, especially for RBT, with lowest densities reported in the spring and significantly large summer and fall increasing trends at Sheep sites downstream of Moose Creek since 2017. Estimates of total salmonid abundance between 2014 and 2019 at the control site SH22.7 (avg. 153 per mile ± 42 SE) were substantially lower than 1970 and 1992 estimates of 748 and 325 per mile, respectively. Compared to historical data (1970 and 1992) at two Sheep Creek locations near the project area, RBT populations are currently sub-optimal, LOLE and MOWF have increased, and these sites are now devoid of native WCT. Some significant site declines in RBT abundance were noted at impact sites SH18.3 and SH17.5 between 2014 and

2019; LOLE and MOWF have increased at the SH18.3 site.

We scanned all salmonids captured during the surveys from 2016-2019 with a Biomark 601 pit-tag reader. No pit-tagged LOLE or RBT were detected at any sites above the USFS boundary during the seasonal fish surveys in 2016; only tagged MOWF (n=4) were detected in the BBC project area at sites SH19.2 and SH18.3. No pit-tagged fish were detected during any survey in 2017, 2018 or 2019.

Each fall from 2016 to 2019, redd counts were performed on approximately 3.2 miles of Sheep, Little Sheep and Moose Creeks combined. In 2016, LOLE redd counts averaged 3.5 and 2.8 per 100 meters (m) at sites SH19.2 and SH18.3, respectively. In 2017, redd counts at these sites decreased by about 66% (~1 per 100 m), and in 2019 averaged <1.0 redd per 100 m EBT redds averaged 3.3 per 100 m (2016) in Little Sheep Creek (LS.1) but have declined to ~1 redd per 100 m in all years since (2017-2019).

We performed whole body metals analysis on RMCOT and juvenile trout at two sites above and three sites below the BBC project area to determine baseline levels for the 4th year; we added Moose Creek in 2019 as a reference comparison. Between-year variation in some metals (iron and selenium) has been more significant than between treatment sites (C vs. I).

Macroinvertebrate Communities. It is important to document baseline aquatic communities in the project area streams prior to any mine development. We qualitatively and quantitatively documented macroinvertebrate communities and biological integrity at 12-15 stream reaches between 2014 and 2019, many of these sites now have 5 years of data. Overall, 148 unique macroinvertebrate taxa were reported from the 170 macroinvertebrate assessment samples collected.

Results from the 2019 sampling reflect some of the effects that large flushing flows can have on the benthic communities by reducing benthic densities and taxa richness while increasing biointegrity because tolerant taxa inhabiting the silt in the substrate are removed which decreases the Hilsenhoff Biotic Index (HBI). Across all sites, the macroinvertebrate communities in 2019 have reported the 2nd highest biological integrity scores (avg. DEQ Mtn. MMI =60.4) since their highest average of 60.7 in 2016. The Sheep Creek control site SH22.7 also increased DEQ Mtn. MMI scores over the past 2 years (avg. 69.7) and now resembles the biotic integrity of the TN9.3/9.4 reference (avg. Mtn. MMI=70.4). Overall, Sheep Creek control sites MMI scores averaged 62.6 (n=10) which is slightly higher than the impact MMI scores of 62.0 (n=20), both ranks are slightly below the impairment level by DEQ standards. Macroinvertebrate Hess sample DEQ MMI scores from 2016 and 2019 scored lower biological integrity than reported for the Environmental Monitoring and Assessment Protocol (EMAP) reach wide (RW) samples, except at Sheep Creek SH15.5D where the Hess samples scored substantially higher. In 2019, SH19.2(C) reported the highest number of combined mayfly, caddisfly and stonefly taxa (Ephemeroptera, Plecoptera, and Trichoptera [EPT]) at 33 species (EMAP RW sample), while the highest avg. EPT taxa per Hess sample was SH22.7(C) in 2017. Average macroinvertebrate richness across all sites was 44.7 taxa, while EPT taxa averaged 20 per site. Mountain streams with less than 20 EPT taxa per site are considered slightly impaired by most measures. Both Little Sheep Creek sites were ranked impaired by the DEQ MMI with scores <63. Six of the 11 sites showed significant improvements in biotic integrity in both the MMI and HBI since 2014; these are sites SH17.5, SH22.7, TN9.3, TN9.4, LS.1 and AQ8. The DEQ

MMI and HBI ranked upstream (control) and downstream (impact) reaches of the Sheep Creek similarly, and most years, there has been no significant difference between Sheep Creek control and Tenderfoot Creek reference. It is important to note that the overall average HBI scores in 2019 have significantly improved (decreased HBI scores) since 2018 as total species richness has decreased. This happened last between 2014 and 2016.

Periphyton Communities. Overall, 167 unique diatom and algae taxa were reported from the 49 periphyton assessment samples collected from 2014 to 2019. Diatoms were the dominant benthic taxa during most years of the study except in 2017. The diatom, *Didymosphenia geminata* (a.k.a. rock snot) which can reach nuisance levels, was abundant in the Tenderfoot Creek reaches in 2014 and 2016, but not found in the Sheep Creek samples. The Cyanobacteria, *Phormidium* was the dominant, non-diatom species at 4 of 10 sites in 2016 and 3 sites in 2017; especially in the meadow reaches (SH19.2, SH18.3), LS.1 and the canyon site (SH17.5). Abundant filamentous algae outbreaks were visually observed in 2015 and 2016 at the lower sites (SH15.5U and SH15.5D), but not in 2017. Filamentous algae levels in 2019 at some Sheep Creek sites, SH22.7 and SH19.2, have reached nuisance levels that we saw in 2015 and 2016 based on Chl-*a* biomass. This was confirmed with *Cladophora* being the dominant periphyton taxa at both sites.

Based on Teply's TDI, the lower meadow site SH18.3 (I) had the highest probability (82%) of impairment (2016-2018) followed by SH19.2 at 61%. Based on the TDI, other Sheep and Little Sheep Creek sites had a 40% or less chance of being impaired. The Tenderfoot Creek reference sites were ranked least likely to be impaired (<20%) with the diatom index (2014-2018), but this increased to ~30% in 2019.

Amphibian and Reptile Incidentals. One juvenile western toad (*Anaxyrus boreas*), a MT SOC species, was observed at the SH22.7(C) reach during summer 2016 surveys, but not seen again. The Columbia Spotted Frog (*Rana lutieventris*) has been recorded at multiple Sheep and Little Sheep Creek sites during the summer, as well as lower Coon Creek. Terrestrial garter snakes (*Thamnophis elegans*) have been observed along the banks of Tenderfoot Creek (TN9.3, TN9.4) and at Moose Creek (MO.1) during summer and fall surveys.

Conclusions. The 2019 data has added another year to one of the most comprehensive studies of multiple aquatic communities across a stream basin in the Missouri River Watershed. Aquatic communities surveyed between 2014 and 2019 at Little Sheep Creek, Sheep Creek, Coon Creek, Tenderfoot Creek and Moose Creek sites have exhibited some large swings in their natural variability across the years with seasonality, stream flows and water temperatures being the most significant environmental drivers.

During low flow years, riparian livestock use and sedimentation are exacerbated and aquatic macroinvertebrate, Chl-*a* and periphyton communities responded with elevated signs of nutrient enrichment (higher tolerance/biomass and lowered biotic integrity) across most sites. These affects were less prevalent in Tenderfoot Creek. The biological integrity trends have improved at many sites with improved stream flows since the summer 'flash-drought' of 2017. However, riparian habitat at SH22.7, SH15.5U, LS.1, LS.7 and TN9.3 has been degraded by livestock use, and SH17.5 and SH22.7 are "at risk" because of the county road/highway effects on the hydrology. Macroinvertebrate community metrics were not significantly different between Sheep Creek control (n=2) and impact (n=4) sites in 2019, except for higher EPT taxa reported in the Control reaches. 2019 is one of two years where DEQ Mtn. MMI scores are not significantly different between the Tenderfoot Creek Reference (n=2) and Sheep Creek sites (n=6)

Fish species richness and diversity were higher in the Sheep Creek sites than at the Tenderfoot or Moose Creek reference reaches and were not significantly different between the upstream control reaches and the downstream impact reaches. Trout densities, catchable size and biomass were lower (2014-2018) at Sheep Creek sites with angler access (SH22.7, SH15.5U), but these trends have been reversed in the last 2 years for SH15.5U/SH15.5D near the fishing access site (FAS), which now report some of the highest salmonid densities and biomass of all Sheep Creek sites.

Between 2014 and 2019, an improved understanding of the seasonal fish movement patterns within the BBC Sheep Creek study reaches has developed: adult LOLE appear to be largely resident in the meadow reaches (SH18.3 & SH19.2) due to multiple recaptures in the same reaches between years and seasons. They may also be using these home range sections for spawning based on redd count numbers and lack of new pit-tagged study fish collected. Using mark and recapture methods at Sheep Creek sites in 2018 has increased the number of trout detected from previous years, across the 6 Sheep Creek sites an average of 18% (0-33%) of 2018 marked salmonids were recaptured in 2019 surveys.

Adult RBT (>8 inches) were reported at low densities in Sheep Creek reaches during the previous spring electrofishing surveys (2015-2017), and in 2018 and 2019, we found no redds in the monitoring reaches between stream miles 15.1-22.7. These RBT have presumably migrated to tributaries (Moose Creek is a documented spawning area) or other Sheep Creek reaches for spawning. Recent declines in RBT densities in the meadow reaches may be due to beaver dams preventing recolonization (no RBT were collected at SH19.2 in 2019). No pit-tagged RBT have been detected within the BBC project boundary during any season and are likely using Moose Creek for most of the spring spawning activities. Evidence of this were high densities of young, year-class RBT and CTxRBT hybrids collected in the fall of 2017 and 2018 within and downstream of Moose Creek.

MOWF were the most abundant salmonid at SH18.3 between 2016 and 2019 and were the only pit-tagged fish species documented to be migrating into the project area. Juveniles of most salmonid species used lower Little Sheep during all seasons, while adult LOLE used lower Little Sheep Creek in 2016-2019 as a winter thermal refuge. Little Sheep (LS.1) is typically 3-4ºC warmer than Sheep Creek during all seasons.

Overall, salmonid densities in the summer of 2019 were highest at the impact site SH15.5U downstream of the FAS; while in 2018, Moose Creek reported the highest RBT densities. Moose Creek is the reproduction and recruitment source stream for supplying RBT to Sheep Creek sites downstream of the confluence (SH15.5U and SH15.5D), as young, 1st and 2nd year class (50-100mm), RBT were documented at high densities in 2018 (~1,000 per mile) during the fall sample period.

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

The Black Butte / Sheep Creek basin, 15 miles north of White Sulphur Springs, Meagher County, Montana, is currently undergoing exploration and permitting for a proposed underground copper mine (hereafter known as BBC Project). Baseline data documenting the condition of the aquatic ecosystems that could potentially be affected by the BBC project (pre-impact) are essential to determine what effects the mine might have on the fish and wildlife in, and downstream of, the affected area (post-impact). Environmental Assessments (EA) often address Threatened and Endangered (T&E) species (no potential aquatic T&E species occur in the basin, [USFWS 2016]) and the presence of Montana Species of Concern (SOC), but until recently completed on-the-ground surveys were conducted, the presence of MT SOC or other sensitive native species assemblages may not have been considered.

No previous standardized biological sampling or monitoring had been conducted in the BBC project area of Sheep Creek prior to this study (Montana Department of Environmental Quality [DEQ] 2007), (Montana Department of Fish, Wildlife and Parks [MFWP] 2014), (Montana Natural Heritage Program [MNHP] 2015); this would have provided a long-term perspective on the baseline aquatic conditions. Although, a mussel survey was performed upstream of the project area and downstream on Sheep Creek at the Smith River Road in 2009 (Stagliano 2010). Additionally, Sheep Creek upstream of the control site (SH22.7) had two widely spaced trout population estimates in 1970 and 1992 (MFWP 1973, MFWP 2014) and Sheep Creek near Moose Creek (RM16.5) had a single fish sampling event conducted in 1970 (MFWP 1973). In 2015, DEQ assessed Chlorophyll-a (see section 3.7 Chl-*a* Biomass), qualitative macroinvertebrates, sediment metals, nutrients, periphyton, and *E. coli* upstream and downstream of the project area (DEQ 2017). Because of the high concentrations reported during this 2015 sampling, *E. coli* and aluminum are listed as causes of impairment to Sheep Creek's Primary Contact/Recreation and Aquatic Life Use (DEQ 2017). Before Tintina's 2014 sampling and this DEQ 2015 project, only a single Environmental Monitoring and Assessment Protocol (EMAP) macroinvertebrate sample had been collected from Sheep Creek near its confluence and at the Fishing Access Site (FAS) in 2005 (DEQ 2007).

Large gaps in baseline surveys for macroinvertebrates, fish, and mussels existed both temporally and spatially in the BBC Project basin prior to this study. A prior baseline study or the use of existing data can help estimate the natural variation that is typical of the population(s) to be monitored and to determine whether trends can be reliably detected (Dauwalter et al. 2009). Unfortunately, only two previous fish population estimates from 2 reaches in 1970, and one in 1992 are available near the project area (MFWP 1973, MFWP 2014). The species composition and population estimates reported during these historical surveys will be compared with the results from 2014-2019. The 1992 population estimate for upper Sheep Creek reach survey was reported as "trout per mile" with no species listed, but after talking to the retired USFS biologist, the fish composition was reported to be roughly equal proportions of brook trout (EBT) and rainbow trout (RBT) and no westslope cutthroat trout (WCT) (MFWP 2014; L. Walch, pers. comm. 2018). Recent fish movement studies performed by MFWP have documented RBT and MOWF from the Smith River using Sheep Creek in their spring and fall spawning migrations (Grisak 2012, 2013: pers. comm.). These studies did not report any tracked fish moving all the way upstream into the BBC Permit area. More recently, in a Montana State University (MSU)/MFWP fish movement study, numerous pit-tagged RBT were found to spawn in Sheep Creek ~11 miles upstream from the Smith River or moved into Moose Creek (Lance and Zale 2017) which is ~2.5 miles downstream from the BBC project area.

The objective of this study is to identify and quantify baseline aquatic communities (fish, macroinvertebrate, periphyton and mussels) and habitat conditions in the streams of the BBC project area prior to any mine construction or development. This study is essential to understanding and potentially mitigating impacts to habitats and species during and after mine operations. The concurrent use of multiple aquatic assemblages provides a broader perspective in assessing ecological health, as each biological community may respond differently to sets of environmental variables or stressors (Townsend et al. 2003). Peripyton and macroinvertebrates respond more quickly to environmental stressors, while fish communities may reflect impairments over a longer time scale (Barbour et al. 1999).

1.2 STUDY AREA DESCRIPTION AND MONITORING LOCATIONS

The entire Tintina BBC Project study area lies within the Middle Rockies Ecoregion (17q) (Woods et al. 2002), specifically the Little Belt Mountains. Sheep Creek is a 36-mile-long tributary to the Smith River occurring in Hydrologic Unit 10030103 with a total watershed area of ~500 km^2 (194 sq. miles). The study area near the proposed BBC mine area is approximately 18.5 miles upstream from the confluence with the Smith River (**Map 1**, see Hydrometrics Appendix B). The Sheep Creek watershed upstream from the project area drains approximately 202 km^2 and is located approximately 15 miles north of White Sulphur Springs, Montana. Little Sheep Creek, a Sheep Creek tributary, lies within the project area and drains a watershed area to the south of the county road of approximately 30 km^2. Pre-impact baseline sampling from 2014 to 2019 was established in 2014 in the Sheep Creek and Little Sheep Creek reaches upstream and downstream of the proposed mine activity drainage corridor (**Map 1**). Tenderfoot Creek, a 40-mile-long tributary to the Smith River, has a total watershed area of 281 km^2 and was chosen as the off-site control reach; an estimated watershed area of 203 km^2 is drained above the reference reach (**Map 1**). Watershed areas upstream of the Sheep Creek project area sites and Tenderfoot Creek reference reaches are nearly identical. Eight main-stem reaches in Sheep and Tenderfoot Creeks, and three tributary reaches in Little Sheep Creek (2 reaches) and Coon Creek (1 reach) have been visited seasonally (**Map 1, Table 1**). Moose Creek, an 11-mile-long tributary to Sheep Creek, was added to the BBC AMP in Fall 2017; fish population estimates and redd counts were performed from 2017-2019. Brushy Creek, a tributary to Little Sheep Creek, 40 m upstream and downstream of the proposed haul road (Lat. 46.771327, Longitude. -110.89379) was sampled in the spring and summer of 2017. Spring seasonal fish sampling at the Tenderfoot Creek sites was never accomplished during any year due to impassable road conditions (USFS White Sulphur Springs office, pers. comm.). During the spring sampling periods of 2015, 2016 and 2017, stream flows at most Sheep Creek sites were above optimal levels for efficient electrofishing and estimates of salmonid abundance should be considered qualitative. No further attempts at spring fisheries population estimates will occur unless the BBC AMP is modified by the FWP fisheries biologist. Spring redd counts will occur for Sheep Creek and tributaries in the BBC project area.

There are no current U.S. Geological Survey (USGS) streamflow gauges located on any streams in the BBC project area to consult, and we rely on stream flow data collected by Hydrometrics, Inc. (**Table 2, Figure 1**). During the last 6 years, spring run-off has been initiated in late-April with a low elevation snow-melt pulse; this is 10-14 days earlier than the 30-year historical flow average (**Figure 1**). Spring run-off conditions usually persist until mid-June and early-July, but in 2019, stream flows remained 2 times higher than normal base flow throughout July (**Table 2, Figure 1**) (see Hydrometrics 2019, Appendix B). Flows recorded at Sheep, Little Sheep and Coon Creeks during the dates closest to our seasonal sampling events are presented in Table 1 (Hydrometrics 2019). Peak and annual average stream flows for Sheep Creek had been declining since the previous high flows of 2014, until the 2018 water year, and then 2019 annual average discharge eclipsed all prior years (**Figure 1**). Flows recorded at Sheep SH17.5/SW1, SH22.7/SW2, Little Sheep LS.1/SW14 during the July 2019 sampling period were ~50 cubic feet per second (cfs), 44 cfs, 4.0 cfs, respectively; these are 2-4 times the flows reported on the same date in 2018. Coon Creek atAQ9/SW3 has remained relatively stable between these years (**Table 2**).

Table 1. Aquatic Monitoring Station locations at the downstream (D/S) and upstream (U/S) ends of the assessment reach**.** Station names denoted with SW are associated with Hydrometrics surface water monitoring sites. Site codes are based on river miles (RM). Average channel wetted width (WW) is the average of 5 transects measured during summer base flows.

Site RM code	Old Site Code	Station Name	BACI Type	Avg. WW (m)	Reach Length (m)	Latitude	Longitude	Elev. (m)	Location Comment
SH22.7	SHEEP AQ2	Sheep Creek @ SW2 (D/S)	Control	8.2	320	46.771973	-110.853445	1743	Upstream of Castle Mtn Ranch off US 89
		Sheep Creek @ SW2 (U/S)				46.771977	-110.851741		
SH19.2	SHEEP AQ3	Sheep Creek (D/S)	Control	9	360	46.777247	-110.898818	1716	Hansen meadow Reach U/S of Little Sheep Creek
		Sheep Creek (U/S)				46.777667	-110.898003		
SH18.3	SHEEP AQ4	Sheep Creek (D/S)	Impact	8	320	46.785116	-110.90883	1706	Lower Meadow Reach on the USFS boundary
		Sheep Creek (U/S)				46.784465	-110.89683		
SH17.5	SHEEP AQ1	Sheep Creek @ SW1 (D/S)	Impact	15	600	46.795122	-110.910367	1697	Downstream Canyon Reach on USFS land.
		Sheep Creek @ SW1 (U/S)				46.793008	-110.911062		
SH15.5 DS	SHEEP AQ10,11	Sheep Creek (D/S)	Impact	15.7	~1,000	46.81598	-110.94058	1652	Fishing Access Site (2 miles D/S of AQ1) DS to the Davis Ranch
SH15.5 US		Sheep Creek (U/S)				46.81112	-110.92398		
SH.1	na	Sheep Creek (D/S)	Impact	16	150	46.804281	-111.182992	1320	New Monitoring Reach 0.1 mile U/S confluence
		Sheep Creek (U/S)				46.804404	-111.180809		
MO.1	na	Moose Creek (D/S)	Control/ Reference	5.2	210	46.803451	-110.914155	1661	New Monitoring Reach 0.1 mile U/S confluence
		Moose Creek (U/S)				46.804935	-110.91313		
TN9.3	TEND AQ5	Tenderfoot Creek (D/S)	Control/ Reference	10	400	46.95049	-111.14739	1435	Lower Reach at South Fork Tenderfoot confluence
		Tenderfoot Creek (U/S)				46.95077	-111.14447		
TN9.4	TEND AQ6	Tenderfoot Creek (D/S)	Control/ Reference	10.2	410	46.95018	-111.14362	1438	Upper Reach U/S of USFS boundary
		Tenderfoot Creek (U/S)				46.95032	-111.14365		
LS.1	LSHEEP AQ7	Little Sheep Creek (D/S)	Impact	2.1	150	46.775038	-110.89779	1718	500m D/S of County Road Culvert and Haul Road
		Little Sheep Creek (U/S)				46.775897	-110.89849		
LS.6	LSHEEP AQ8	L. Sheep Creek DS SW8 (U/S)	Control	1.5	150	46.77147	-110.8878	1728	100m U/S of the Future Haul Road Culvert.
		L. Sheep Creek DS SW8 (D/S)				46.77145	-110.88644		
C.5	COON AQ9	Coon Creek @ SW3 (D/S)	Impact	0.5	150	46.77871	-110.90834	1708	Upstream of County Road culvert at SW3 site
SM_DS	SMITH	Smith River D/S Sheep Cr.	Impact	20	150	46.804	-111.1841	1316	Downstream and Upstream of the Sheep Creek Confluence
SM_US		Smith River U/S Sheep Cr.	Control			46.8041	-111.1824		

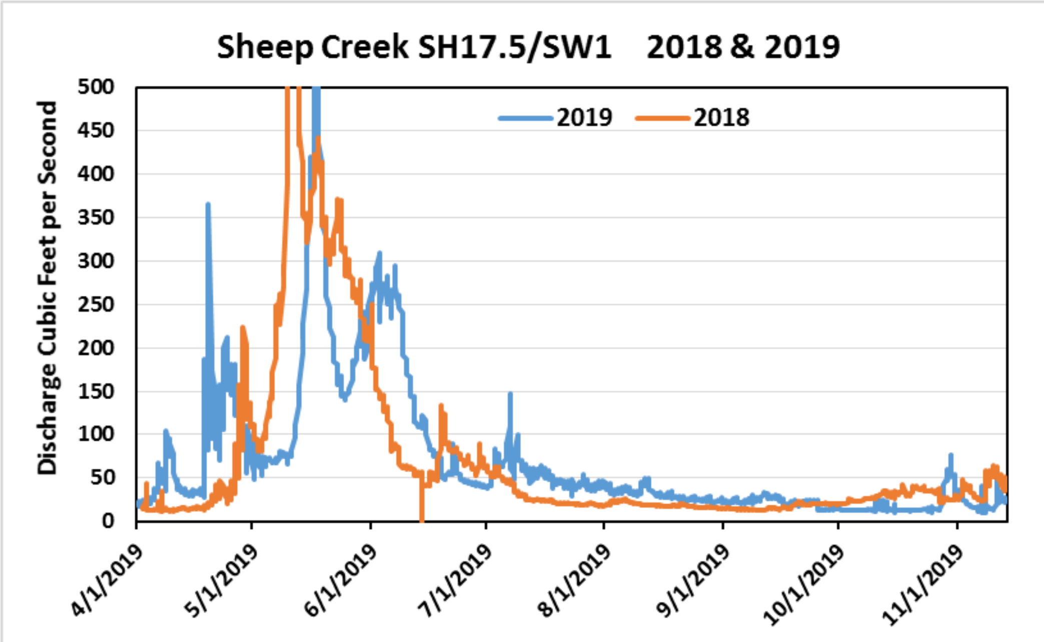

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Montana
Project Location
Tenderfoot Creek
TN9.3
TN9.4
Sheep Creek
Moose Creek
Big Butte Creek
SM-DS
SH.1
SM-US
SH15.5 DS
SH15.5 US
M.1
SH17.5
SH22.7
SH18.3
LS.6
C.5
AQ8 old
Coon Cr.
SH19.2
LS.1
Little Sheep Creek
89
N
Miles
0
2
Document Path: O:\T-Z\TTBozeman\114-710301A_BlackButte\GIS\ArcMap\AquaticSampling2.mxd
Date: 11/20/2017
Legend
Aquatic Sample Point
Stream
Mine Permit Boundary
Map 1
Aquatic Sampling Sites
Tintina Resources
Black Butte Copper Mine
Meagher County, Montana

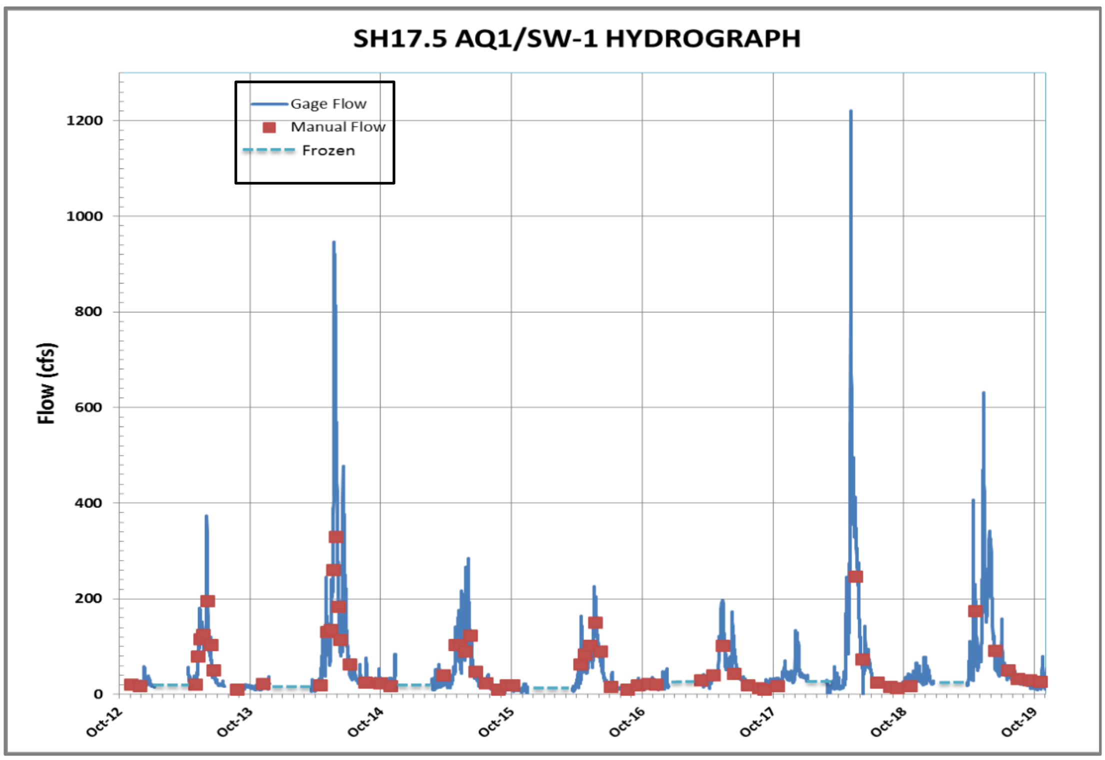
Table 2. Stream Discharge (cfs-cubic feet per second) reported at four surface water quality stations (SW) and associated Aquatic Monitoring Reaches (AQ) closest to the sampling dates from 2014-2019.

		2014		2015		2016				2017			
		Sum	Fall	Spring	Sum	Spring	Sum	Fall	Fall	Spring	Sum	Fall	Fall
Site	**Stream**	**8/21/14**	**9/3/14**	**4/29/15**	**6/25/15**	**4/29/16**	**7/14/16**	**9/20/16**	**10/22/16**	**4/23/17**	**7/17/17**	**9/11/17**	**10/17/17**
AQ1/SW1	Sheep Creek	25	22	103	47	84.2	17.2	19.7	22.2	40.6	18.9	10.7	17.5
AQ2/SW2	Sheep Creek	19.3	17	82.2	36	68	9.2	16.7	18.5	31.3	14.6	6.8	13.7
AQ8/SW8	Little Sheep	0.54	0.6	1	0.71	0.71	0.51	0.22	0.18	0.8	0.48	0.09	0.09
AQ9/SW3	Coon Creek	0.08	0.07	0.1	0.07	0.14	0.1	0.07	0.08	0.22	0.03	0.21	0.21

		2018				2019			
		Spring	Sum	Fall	Fall	Spring	Sum	Fall	Fall
Site	**Stream**	**4/12/18**	**7/24/18**	**9/17/18**	**10/23/18**	**4/24/19**	**7/25/19**	**9/23/19**	**10/23/19**
AQ1/SW1	Sheep Creek	14.1	25.7	13.2	18.7	174.3	51.2	30.3	26.9
AQ2/SW2	Sheep Creek	9.8	11.7	9.4	13.7	94.0	44.0	24.3	22.0
AQ7/SW14	Little Sheep	0.3	2.3	0.8	0.7	15.5	4.0	1.2	1.3
AQ9/SW3	Coon Creek	0.17	0.15	0.17	0.21	0.18	0.12	0.07	0.09

Figure 1. Stream Discharge (cfs-cubic feet per second) reported at Sheep Creek SW-1 / SH17.5 (2018-2019) (top) and from 2012-2019 (bottom).





2.0 METHODS

Habitat assessments and macroinvertebrate, periphyton, Chl-*a*, and fish surveys were performed on similar dates at the same designated reaches of Sheep, Little Sheep and Tenderfoot Creeks between 2014 and 2019 (**Table 2**). Coon Creek, a potential impact site, was determined to be fishless in 2015, and sampled only for macroinvertebrates from 2015 to 2019, and periphyton in 2018 and 2019. Brushy Creek, a tributary to Little Sheep Creek that will be crossed by a mine haul road, was spot-sampled upstream and downstream of the proposed culvert location for fish in the spring and summer of 2017. Locations of aquatic monitoring sampling sites are presented in Map 1 for the Sheep Creek and Tenderfoot Creek drainages. These survey locations are arranged in consideration of a 'BACI' sampling design: Before {pre-impact}, After {post-impact}, Control {upstream and off-site references} and Impact {within and downstream} in relation to proposed BBC mine activity.

Data Analysis. This BACI sampling design allows for the robust analysis of the seasonally collected data using both univariate and multivariate statistical methods between years, streams, treatments, and stations (Underwood 1991). We will follow an analysis of variance (ANOVA) procedure for asymmetric BACI described by Underwood (1991) and Smith (2002) with a significance probability of 5% (α= 0.05). Baseline aquatic sampling has been completed at 9 sites for 6 years, 4 sites for 4 years and 2 sites added in 2017. This aquatic sampling, prior to any project construction, documents the existing natural variability and the current influence of water quality and other anthropogenic effects on stream communities and habitat. Seven (n=7) sites are Control/Reference and 8 sites are Impact sites for the various aquatic communities (**Table 2**).

In total 15 sites have been sampled; 12 established monitoring stream reaches sampled between 2014 and 2019 with 96 seasonal fish survey events; 170 macroinvertebrate and 49 periphyton samples. No Chlorophyll-a samples were collected by Tintina in 2017 because benthic algal levels had visually been low (<50 milligrams per square meter [mg/m^2], ⅓ the nuisance level of 150 mg/m^2) at all transects of the stream reaches and underwater photographs of the substrate were taken instead. In this report, we present the Chl-*a* levels from Sheep Creek sampled by DEQ in 2015 (DEQ 2017) and the 2018 and 2019 Chl-*a* data collected by Tintina (Section 3.7). Biological community integrity was calculated using typical impairment metrics known to be affected by water and habitat quality and approved by DEQ; macroinvertebrate and periphyton samples were assessed with Montana DEQ's multi-metric indices (MMI) (Teply and Bahls 2006, DEQ 2012b). Macroinvertebrate metrics were evaluated by both the DEQ Mountain and Low Valley Ecoregional Metrics because some sites are on the threshold of the elevation cut-off (1,700 m). Summer macroinvertebrate and periphyton samples were collected within the DEQ recommended time frame for sampling (June 21st-September 30th) (DEQ 2012b). All stream reaches were visually surveyed for amphibians or reptiles during all visits.

2.1 LITERATURE/DATABASE SEARCHES

Information pertaining to aquatic animal SOC that may potentially occur in the project corridor was downloaded from the MNHP database (MNHP 2016). Information pertaining to federally listed T&E aquatic species was obtained from U.S. Fish and Wildlife Service (USFWS) county list (USFWS 2016). Information pertaining to prior fisheries investigations in the area was obtained from the MFWP Fisheries Information System (MFISH) Database (MFWP 2014). Prior macroinvertebrate studies conducted in the project area were obtained from the DEQ's ecological database application or from the DEQ WQ Library Database (Jessup 2006 from EDAS 2014; DEQ 2017).

2.2 STREAM HABITAT / WATER QUALITY ASSESSMENTS

It is important to document existing water quality, baseline aquatic community structure and stream habitat conditions in the study area prior to any mine development. Long-term surface water quality sampling has been conducted at four of the aquatic community sampling sites (SW1/SH17.5, SW2/SH22.7, SW8/LS.7, SW3/C.5) by Hydrometrics quarterly since spring of 2011 (see Table 2, Hydrometrics 2016). Each stream biological assessment reach was divided into 10 equally spaced transects according to EMAP standards followed by DEQ (Lazorchak et al. 1998, DEQ 2012b). The downstream transect (A, T10) was marked (GPS, flagging and photo point) as the bottom of the reach and all ecological assessment protocols started from this point and continued upstream for 40 times average wetted channel width (WW) or a minimum of 150 m to the marked top of the reach (K, T1); this is designated the assessment area or "AA". Stream gradients were estimated using the difference in the upper and lower GPS elevations of individual reaches and dividing by the reach length. Parameters recorded at each transect were: bankfull width (Bkw), wetted width (ww), three channel depth measurements (¼, ½, ¾ of ww), % large woody debris, substrate composition and riparian shading. A stream map of the reach was sketched to scale, so that habitat features (riffle, run, pool) could be quantified. On-site habitat assessments were conducted using the rapid assessment protocol developed for the Bureau of Land Management (BLM) by the National Aquatic Assessment Team (scores 0-24) (BLM 2008). The process for determining Proper Functioning Condition followed Pritchard et al. (1993). Basic water quality parameters (temperature, TDS, pH, conductivity) were recorded prior to biological sampling using an Oakton PCTester 35 water testing meter, recently calibrated for the lower conductivity range. The goal of these evaluations is to characterize local reach geomorphology, riparian and in-stream habitat, and other characteristics that influence aquatic community integrity. Sites ranking higher using these protocols were determined to have higher quality habitat at the local reach-scale. In-stream benthic fine sediment (<6.3 millimeter [mm]) was monitored during the summer base flow period beginning in 2018; this will continue through the initial year of the BBC project site development, through the construction period, and into the operational phase. Benthic surface fines were quantified using a 49-grid sampling device at each quantitative macroinvertebrate Hess sample riffle location as described in DEQ methodology (DEQ 2010, section 2.2.1).

2.2.1 Riffle Grid Toss

The riffle grid toss was performed at locations where macroinvertebrate Hess samples were taken. The riffle grid toss qualitatively measures fine sediment accumulation on the surface of the streambed by enumerating the number of grid corners (49 total) where a particle less than 6.3 mm is identified (grid intersections obscured by algae are removed from the total). A glass-bottom bucket (aqua-scope) is used to visually see and count the number of fine substrate grids in the transect where the grid is randomly tossed (DEQ 2012b) (**Photo 1**). Riffle grid tosses (n=4) were performed prior to the pebble count to avoid disturbances to surface fine sediments according to DEQ protocols (DEQ 2012b).

2.2.2 Pebble Counts

A Wolman pebble count (100 particles) (Wolman 1954) was performed at each riffle encountered in the sample reach providing a minimum of 400 benthic particles measured at each assessment station. If a total of four riffles are not present in the assessment reach, a second pebble count will be performed in the 1st riffle and, if necessary, at the 2nd riffle until a total of four riffle pebble counts are obtained. Particle sizes will be measured along their intermediate length axis (b-axis) and results were grouped into particle size categories (<4mm, 4-8mm, 8-16mm, etc.). The pebble count was performed from bankfull to bankfull channel edge using the "heel to toe" method (DEQ 2012b).

Photo 1. Riffle grid toss procedure (l) and underwater view of grid (r), some obscured by algae.

2.3 FISH COMMUNITY SURVEYS

2.3.1 Population Estimates

A quantitative fisheries population assessment was performed to determine seasonal fish community structure and population densities using two-pass or multiple pass depletion estimates (Zippin 1958, Carle and Strub 1978) and/or Mark-Recapture methods using a Petersen equation with the Chapman modification (Ricker 1975, Van Deventer 1989). We backpack electrofished (Smith Root Models LR-24 and LR-20B) 6 reaches of Sheep Creek and two reaches on Little Sheep Creek, representing upstream control, downstream and impact sites, as well as Tenderfoot Creek (2 reaches) and Moose Creek (1 reach) following MFWP electrofishing protocols (MFWP 2002) (**Table 1, Figure 2**). For the canyon reach (SH17.5) and the FAS (SH15.5U and SH15.5D), we used a Tote Barge equipped with a Smith Root VVP-15 rectifying unit and 2 anodes. Since 2016, reach lengths were extended to at least 150 m (Little Sheep), 300-400 m (Sheep and Tenderfoot Creeks), and 400-500 m for lower Sheep Creek reaches. Moose Creek reach length was calculated to be 210 m (5.2 m WW x 40 m). For depletion methods, fish collected during the first pass were held in buckets or live cars until the second pass was completed (**Figure 2**). If salmonid numbers collected during the 2nd pass were more than 25% of the 1st pass, then a 3rd pass was performed. Fish population estimates are reported as numbers per unit distance (per section or per stream mile) based on two-pass depletion estimates per reach. If a 3rd pass was completed, then a multiple-pass depletion estimate was calculated (Microfish Software 1988).

For the mark-recapture methodology, the initial electrofishing capture run was conducted starting at the designated upstream riffle and proceeded in an downstream direction with 2 anodes and 2 netters fishing all habitat types until the top reach riffle is reached and/or a minimum of 50 salmonids are collected. Salmonids collected from the initial marking pass were anesthetized in batches with tricaine methanesulfonate (MS-222) and all individuals greater than 100 mm in length were marked by a fin clip taken from the dorsal tip of the caudal fin or the dorsal fin. In-stream live cars held all captured fish during processing and recovery until being released back into the same reach. We allowed at least 5-7 days for marked fish to recover and become mixed within the section population before we collected the next sample of fish during a recapture run (Peterson et al 1984, Rosenberger and Dunham 2005). The recapture sampling run occurred in the same reach and manner as the mark electrofishing run. Data collection will record the ratio of marked to unmarked fish by species and size (e.g., 50 mm group classes). Population densities of each salmonid species and size groups captured during the study will be estimated per unit length of stream, where adequate sample sizes permit, using a Petersen equation with the Chapman modification (Ricker 1975, Van Deventer 1989).

All fish collected were identified to species (Holton and Johnson 2003), measured for total length (mm) and weighed (grams) on mass balance scales to determine densities and biomass per reach using standard fisheries techniques (Dunham et al. 2009) (**Table 3, Figure 1**). Fish anomalies (e.g. deformities, eroded fins, lesions, hook scars and tumors), and condition were also recorded during the handling procedures (Dunham et al. 2009). Fish were processed and released within the same section of capture. Young-of-the-year fish (less than 30-40 mm), were noted on the field sheet, if species could be quickly determined, and immediately released to prevent mortality.

In addition to the salmonids, we also estimated populations of the non-game fish in the project reaches. For the rocky mountain sculpin (RMCOT), *Cottus bondi* estimates were made based on single pass depletion numbers or catch per unit effort (CPUE), because sculpin sink or roll after being shocked and are less susceptible to second pass shocking. Each individual shocker-netter team would keep count of the number of sculpin that were “rolled” on the first electrofishing pass even if they were not all netted, and these numbers were added at the end of the reach for the section total. Netted sculpin were measured for length-weight characteristics and five were kept for metals analysis (see **Section 2.3.3**).

Fish population estimates for 2016 and 2019 were calculated using the software program Microfish (Van Deventer 1989; Van Deventer and Platts 1985). This program utilizes an iterative process to incorporate a maximum-likelihood population estimate (Lockwood and Schneider 2012), which is not a feasible approach if calculations are done by hand. This program uses similar equations to those used in previous reports to calculate fish population estimates (Stagliano 2019). However, population estimates in past reports were calculated using a spreadsheet calculation, rather than the Microfish software. For this reason, the past years’ fish data has been recalculated using the Microfish software to ensure consistency in estimates between years. When the population estimate minus the confidence interval was less than the total number of fish collected, the lower boundary of the confidence interval was assumed to be the total number of fish collected. The range for the confidence interval was rounded to the nearest whole number to reflect the reality that there are no ‘partial’ fish.

2.3.2 Pit-tagged Fish

We scanned all salmonids captured during the 2016-2019 surveys with a Biomark 601 pit-tag reader (**Figure 2**). If a pit-tag was detected, the tag number was recorded on the field data sheet along with the other fish biometric data and reported on the MFWP collection permit report.

2.3.3 Fish Tissue Analysis

We collected RMCOT (n=5 per site) and juvenile salmonids (n=5) for baseline tissue metal analysis from 3 sites below the BBC project area and 2 sites upstream, including the Moose Creek reference reach in 2019. Five RMCOT of various sizes (60-100 mm) and five juvenile salmonids (<100 mm, if present) were collected during the fish sampling and humanely anesthetized in an overdose solution of MS-222, rinsed, placed in labelled zip-lock freezer bags and immediately into a cooler on ice. Frozen whole fish samples were delivered to Energy Laboratories in Helena within 48 hours of capture. Homogenized whole-fish samples were analyzed to determine aluminum, arsenic, cadmium, copper, iron, lead, manganese, mercury, selenium, and zinc concentrations (reported as milligrams per kilogram [mg/kg]).

2.3.4 Redd Counts

Redd count surveys were completed for fall-spawning brown trout (LOLE) and brook trout (EBT) for all Sheep Creek and Little Sheep Creek reaches during the last week of October to the second week of November using methods outlined in Thurow et al. (2012). Redd count surveys were performed for spring-spawning RBT during the third week of April to the first weeks of May using the same methods. Moose Creek (MO.1) was added for redd counts in 2017. Streams reaches were walked in 100 m sections with an observer on each bank and redds were counted only if the disturbed benthic area contained two features: 1) a pit resulting from excavation of the redd and covering of the eggs, and 2) a pillow of loose substrate material immediately downstream of the excavated pit (**Figure 2**). Female test pits were not counted. Redd counts for each 100 m section were summed across the number of sections walked, usually 3 to 8, and presented as total redds per reach and average number of redds per 100 m. We identified different salmonid species' redds based on redd size, visibly identifying fish on redds, or habitat selection preferences between LOLE and EBT (Witzel and Maccrimmon 1983), although a small percentage of overlap may occur. Stream redd count reaches were revisited at least once after the initial count to determine if additional redds were made subsequently to the first visit, based on re-count data.

Table 3. Metrics and classification of native (N) and introduced (I) fishes captured during the Tintina Black Butte Study (2014-2019). Trophic: OM = Omnivore, IN = Invertivore, C =Carnivore. Tolerance: TOL=Tolerant, INT=Intermediate, S=Sensitive.

Species	Scientific Name	Trophic *	Feeding Habit †	Repro Guild ‡	General Tol.	Origin	Total Length 3 years	Number of Sites Obs.
Catostomidae								
White sucker (WHSU)	*Catostomus commersoni*	OM	BE	LO	TOL	N	229	6
Mountain Sucker (MOSU)	*Catostomus platyrhynchus*	IN	BE	LO	INT	N	102	1
Cottidae								
Rocky Mountain Sculpin (RMCOT)	*Cottus bondi*	IN	BE	LO	INT	N	86	11
Cyprinidae								
Longnose Dace (LNDA)	*Rhinichthys cataractae*	IN	BE	LO	INT	N	71	5
Salmonidae								
Brook Trout (EBT)	*Salvelinus fontinalis*	IN	GE	LO	S	I	240	10
Brown Trout (LOLE)	*Salmo trutta*	IN/C	GE	LO	TOL	I	269	8
Rainbow Trout (RBT)	*Oncorhychus mykiss*	IN	GE	LO	S	I	260	10
Rainbow Trout x Cutthroat Hybrid (RBT x CT)	*Oncorhychus mykiss x lewisi*	IN	GE	LO	S	I	266	8
Westslope Cutthroat Trout (WCT)	*Oncorhychus lewisi*	IN	GE	LO	S	N	266	1
Mountain Whitefish (MOWF)	*Prosopium williamsoni*	IN	BE	LO	INT	N	190	7

† - BE=Benthic, GE=Generalist, ‡ - Reproductive Guild=Lithophilic Obligate (LO)

2.4 FRESHWATER MUSSEL SURVEYS

The western pearlshell mussel, *Margaritifera falcata* (WEPE), a Montana SOC and USFS sensitive species, was surveyed for at all 8 original BBC monitoring sites in 2014, and we observed no evidence of current or historical presence (Stagliano 2015). During the summer of 2016, we devoted approximately one man-hour of search for the WEPE at each of the two newly added Sheep Creek reaches (SH15.5U and SH15.5D) using the same longitudinal transect survey techniques that we performed in 2014 (Young et al. 2001). The Smith River once had thriving populations of the WEPE, but this species has since been considered functionally extirpated in the basin with the last documented live mussel being reported at the Fort Logan bridge (HWY 360) in 2011 (Stagliano 2015).

Figure 2. Fish and Macroinvertebrate sampling procedures. Clockwise: 1) Backpack electrofishing Sheep Creek (SH19.2), 2) Checking a LOLE for pit-tag, 3) Brown trout redd in Sheep Creek (SH18.3), and 4) Macroinvertebrate collections with a Hess sampler (SH15.5U). Swap pictures 3 and 4

2.5 MACROINVERTEBRATE COMMUNITY SURVEYS

Initial macroinvertebrate assessments were performed in the summer of 2014 at all sites (2015 at Coon Creek) using the semi-quantitative, reach-wide EMAP protocols (Lazorchak et al. 1998). In 2016, we added quantitative macroinvertebrate Hess samples (n=3) collected from riffles at all monitoring reaches (except Coon Creek {all years} and Little Sheep Creek LS.7 {2017}) and processed these according to DEQ's protocols (DEQ 2012b) (**Figure 1**). Macroinvertebrate communities sampled with the semi-quantitatively EMAP RW involves taking a dipnet sample from each of the 10 equally spaced transects within the assessment reach using the EMAP protocol (Lazorchak et al. 1998; DEQ 2012b). Sampling began at the downstream transect (A) and proceeded upstream alternating sampling with the 500-micron D-frame net to the right, left or center of the stream channel, so a random sampling of all habitats is achieved. The ten multi-habitat kicks (~1 square meter) are composited into a 20-liter bucket. All organisms and organic matter in the bucket were elutriated from the inorganic portion and washed onto a 500-micron sieve. The inorganic portion was washed onto a 6.3 mm mesh sieve and examined until no further organics or organisms were present and discarded. The organic/inorganic portion on the 500-micron sieve was transferred to one or two 1-liter Nalgene bottles (unless field sub-sampling was needed), labeled and preserved in 95% ethanol, and transported to the MBS lab in Helena for processing (sorting, identification and data analysis) following protocols DEQ (2012b).

***Data Analysis*.** Macroinvertebrates were identified to the lowest taxonomic level (DEQ 2012b), counted, imported into EDAS (Jessup 2006), and biological metrics were calculated from the data using DEQ's MMI protocols (Jessup et al. 2005, Feldman 2006, DEQ 2012b). We worked with Dan McGuire (McGuire Consulting) to ensure consistent sample processing and taxonomy; for 10% of the samples (n=3) each year, macroinvertebrates were re-identified and enumerated according to DEQ 2012 protocols. Percent Taxonomic Disagreement (PTD) was calculated and has always been <2%. To test our field sampling procedures, one of the larger Reach-wide EMAP samples was split in the field, with each taxonomist analyzing approximately 50% of the sample (Appendix G).

Multiple macroinvertebrate metrics were scored using the DEQ bioassessment criteria and each sample categorized as non-impaired or impaired according to threshold values (DEQ 2012b). If the MMI index score is below the impairment threshold, the individual metrics can be evaluated to provide insight as to why the communities are different from the reference condition (Barbour et al 1999, Jessup et al. 2005). The MMI impairment threshold set by DEQ is 63 for the Mountain Stream Index (48 for the Low Valley Stream Index); any scores above this threshold are considered unimpaired (DEQ 2012b). Macroinvertebrate community parameters analyzed will include density, taxa richness, total number of

Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa, percent non-insect taxa, percent burrower taxa, the percent Heptageniidae, percent EPT individuals, Shannon-Weaver diversity index, and the Hilsenhoff Biotic Index (HBI) modified for Montana (Jessup et al. 2005). The HBI is an informative stand-alone metric, which measures the tolerance of a macroinvertebrate community to organic enrichment (Hilsenhoff 1987). Tolerance values are based on a 0-10 scale, where zero-ranked taxa are most sensitive and 10-ranked taxa are most tolerant to pollutants. HBI values of 0-3.0 in mountain streams indicate no organic pollution (excellent conditions), while 3.0-4.0 indicate slight organic pollution (very good) and 4.0-5.0 is moderate organic pollution. HBI scores are evaluated using a threshold value of 4.0 as a core indicator of organic or sediment impairment (DEQ 2011). The percent occurrence of the mayfly family Heptageniidae has been shown to be a good measure of a community's sensitivity to heavy metal impacts, since they are considered the most sensitive taxa group to metals and are calculated as a separate metric (Winner et al. 1980, Clements 1991, Nelson and Roline 1993).

2.6 PERIPHYTON COMMUNITY AND BENTHIC CHLOROPHYLL-A SURVEYS

Periphyton communities were sampled semi-quantitatively from each of the ten transects within the assessment reach using the EMAP Reach-Wide protocol (Lazorchak et al. 1998), a.k.a. Modified Periphyton Field Procedures (DEQ 2011). Cobbles selected for sampling began at the downstream transect (A) and proceeded upstream alternating with the macroinvertebrate sampling to the left, right and center channel. Sampling periphyton for this study followed the standard methodology, preservation and quality assurance protocols specified in the DEQ Periphyton Sampling and Analysis Plan (DEQ 2011). Rhithron Associates, Inc. (Missoula, MT) is the DEQ approved contract lab that processed and identified the periphyton samples. Periphyton biointegrity metrics were generated and interpreted according to Teply and Bahls (2006). The >50% probability of impairment occurs at about 17.9% relative abundance of an increaser taxa (PRA); this is the threshold for sediment impairment reported by Teply (2010) and used by DEQ as a Core Indicator Assessment (DEQ 2011).

Quantitative benthic chlorophyll-*a* samples were collected from each site sampled for periphyton following modified DEQ standard operation protocols (DEQ 2011). Eleven equidistant transects were established along the site reach. The template sampling method was used at all transects dominated by small boulders, cobble, and gravel (DEQ 2011). We modified this procedure so that composite samples (6 rocks each) were collected at 5 randomly chosen transects out of the 11, and kept separate rather than combining them into one composite sample as is the case for the periphyton samples (DEQ 2011, see NWE Environmental Research). If field personnel visually assess the site and decide benthic algal chlorophyll-*a* is low (<50 mg/m^2, ⅓ the nuisance level of 150 mg/m^2 [Dodds et al. 1997, Supple et al. 2009]) at all transects of a stream reach, underwater photographs of the stream substrate at all 11 transects were taken in accordance with Section 7 of DEQ's standard operation procedure (DEQ 2011) rather than collecting chlorophyll-*a* samples. Benthic algal chlorophyll-*a* data are evaluated against recommended criteria; threshold values: 120 mg Chl-*a*/m^2 or 35 g AFDW/m^2 for n≥3 samples as a core indicator for sediment assessment (DEQ 2011).

Based on these assessment methods, one composite periphyton sample and up to five composited chlorophyll-*a* samples will be collected at each site reach prior to collecting the macroinvertebrate EMAP RW samples.

2.7 AMPHIBIAN SURVEYS

Adult or larval amphibians and reptiles encountered while shocking, seining or walking the designated stream reaches were identified to species, counted and recorded, even if they were not captured.

Photo 2. Tenderfoot Creek TN9.3 reference reach: cattle crossing near unstable banks in 2017 and electroshocking a pool in 2019.

3.0 AQUATIC ASSESSMENT RESULTS

We evaluated and sampled 15 stream reaches in the monitoring study plan: 2 Intermountain River Reaches (classified B003-Smith River, upstream and downstream of Sheep Creek); 9 main-stem mountain streams: Sheep Creek (n=7) and Tenderfoot Creek (n=2) sites classified as (C003); a small forested mountain stream (D003-Moose Creek), and 3 headwater stream tributary reaches (D001- Little Sheep (n=2), and Coon Creek) (Stagliano 2005) (**Table 2**).

3.1 AQUATIC SPECIES OF CONCERN (SOC)

The MNHP database (MNHP 2016) indicated the occurrence of the western toad (*Anaxyrus boreas*), a Montana SOC amphibian species, within 1.6 kilometer (km) of the Sheep Creek SH22.7 (AQ2) site, and we observed one juvenile toad during our 2016 summer surveys at this site. We have not observed this species during any other site visits between 2014 and 2019. The WEPE, a MT SOC and USFS sensitive species, has not been observed during any of the targeted aquatic surveys performed between 2014 and 2016 or incidentally in the project area. The MT SOC, westslope cutthroat trout (WCT) (*Oncorhychus clarkia lewisi*) is reported to occur in the BBC project corridor of Sheep Creek, but there have been no recent documented occurrences, only professional opinion based on surveys from 1970 (MFWP 2014, MNHP 2016). Pure WCT have been documented in upstream tributaries to Sheep Creek (Daniels Creek 90-99% and Jumping Creek 100%) by MFWP (2014), so it is possible WCT could be in the study area at low densities. WCT (>90% pure) are documented to occur about 7 miles upstream of the Tenderfoot Creek reference reach, TN9.4 (AQ6) and in the South Fork Tenderfoot Creek which enters the Tenderfoot near TN9.3 (AQ5) (MFWP 2014) and one pure WCT may have been collected in 2017 (**Photo 3**). We have only periodically collected CT x RBT) at the Sheep Creek sites over the sample years No genetics testing has been done to determine if any of the CT x RBT hybrids in Sheep Creek are ≥90% pure; though, it is our professional opinion they are not. No other aquatic SOC were documented to occur within the project area, and we did not find evidence of any aquatic SOC during our seasonal, on-site surveys.

Photo 3. A typical CT x RBT hybrid collected in Tenderfoot Creek and occasionally in Sheep Creek (left) and a >90% pure WCT collected in 2017 and 2018 in Tenderfoot Creek TN9.3 reach (right).

3.2 HABITAT EVALUATIONS

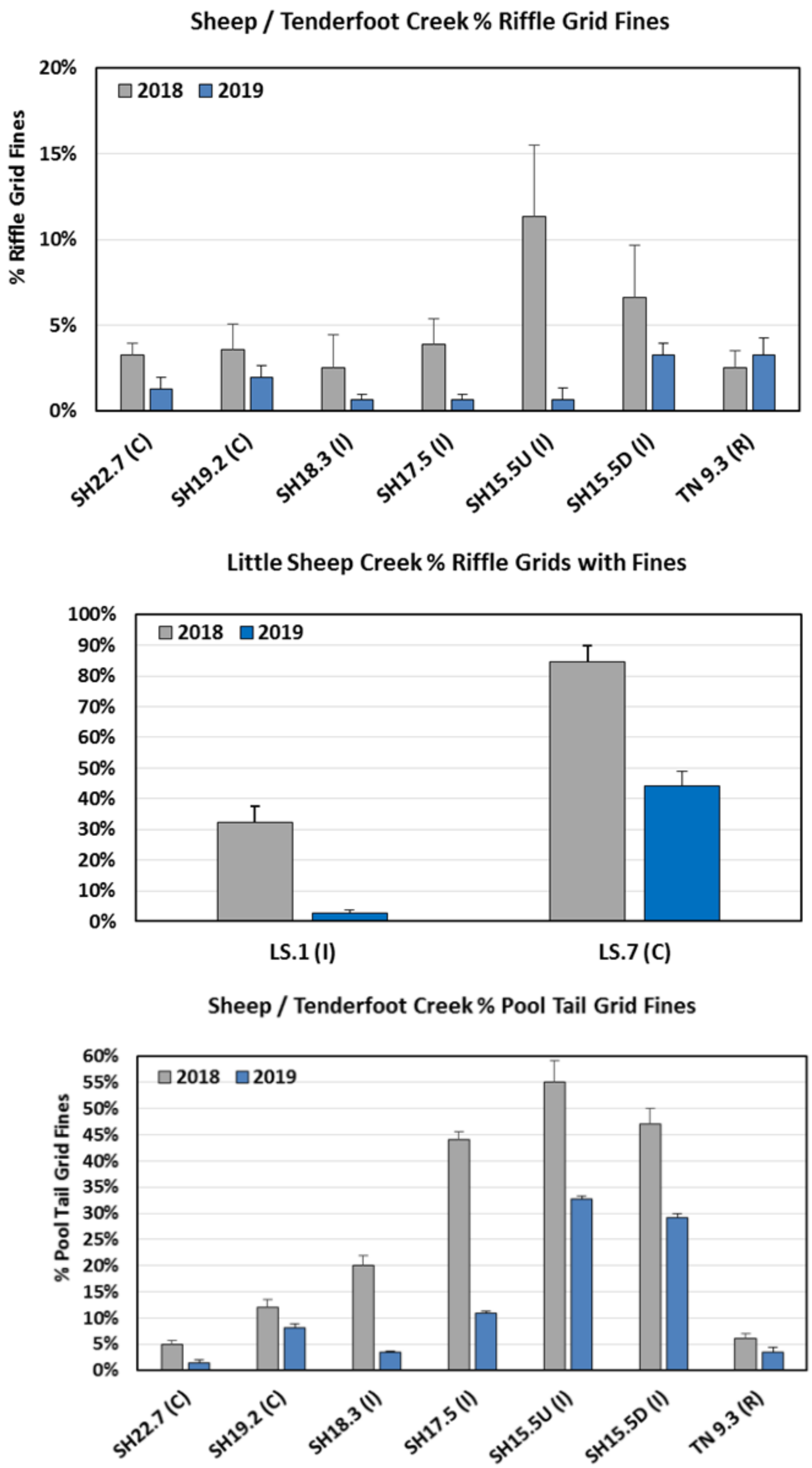
Of the twelve sampling reaches evaluated in the study area, six were found in Proper Functioning Condition (PFC) with a stable trend and six were Functional-at-Risk (FAR) (**Appendix G**). Sites were ranked FAR because they had riparian habitat altered recently or historically by cattle {Little Sheep LS.1 and LS.7 (AQ8), Sheep Creek SH22.7 and SH15.5U, Moose Creek (MO.1), Tenderfoot Creek (TN9.3)} (**Photo 2**), or because of human stream encroachment or manipulation (SH17.5 and SH22.7) (**Appendix G**). Highest site integrity scores using both the BLM Habitat and PFC Assessment methods were recorded in the upper (SH19.2) and lower (SH18.3) meadow Sheep Creek reaches, SH15.5D, and the Tenderfoot Creek TN9.4 site (**Appendix G**). Sites reporting lower habitat scores were often structurally degraded by cattle and had high associated livestock use indices (LS.7/AQ8, Sheep SH22.7, and TN9.3) (**Photo 2, Appendix G, site photos, Appendix A**). It is important to note that the riparian habitat of the Tenderfoot Creek reference reach (TN9.3) (**Photo 2**), as well as the Sheep Creek SH22.7 (C) site, are moderately degraded (**Appendix G**).

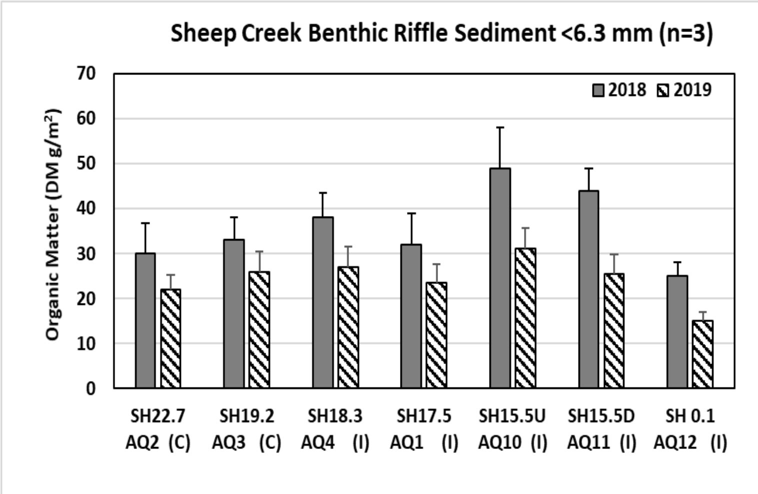
We mapped stream reach habitat features during the initial site set-up in 2014 following EMAP protocol and again, in 2016, when stream reaches were lengthened (**Appendix G**). Stream gradient averaged 1.4% (0.6 - 2.2%) across all sites with the steepest drop reported at Sheep Creek impact reaches, SH17.5 and SH15.5D, and the lowest gradient at Coon Creek CN.5 (Stagliano 2019). Based on reach gradient, stream geomorphology and bottom substrate characteristics, Sheep and Tenderfoot Creek sections are broadly classified as Rosgen C3-C4, while Little Sheep Creek has characteristics of E4-F4 classes, being moderately entrenched at the upper LS.7/AQ8 and some sections of LS.1; Coon Creek has geomorphic characters of an F4 stream (Rosgen 1996). Stream habitat morphology is dominated by riffle and runs at all sites; Sheep Creek averaged 80% riffle/run, Moose Creek 84%, Coon Creek 99%, Little Sheep Creek 73% and Tenderfoot Creek 75% of the total stream reach. Tenderfoot Creek sites had 5% more pool area than Sheep Creek overall and are closest in geomorphology to SH22.7 (C) and SH19.2 (C) (**Appendix G**). The site SH15.5D (I) has similar stream geomorphology to the canyon reach SH17.5 (I) with steeper riffle/run sections and large cobble/boulder, while SH15.5U (I) shares characteristics with the meadow reach SH18.3 (I) (i.e., lower gradient riffles and deeper pools) (**Table 4**).

3.2.1 Benthic Sediment Evaluations

We evaluated stream benthic fine sediments according to the BBC AMP in 2018 and 2019 with pebble counts, Hess riffle sediments (n=3) and sediment grid tosses (n=4) at seven to nine sites; the grid toss could not be performed in Coon Creek because of the narrow width and shallow depth, nor was the Hess sampler used in Coon Creek. All sites reported higher % silt in the riffle grid tosses and the Hess samples in 2018 compared to 2019, and lower Sheep Creek impact sites SH15.5U and SH15.5D have significantly decreased amounts of fine sediments in both riffles and pools in 2019 (**Figure 3**). Reductions in benthic silt amounts <6.3 mm were reflected in the Hess sediment and grid tosses at most sites in 2019; this may be linked to higher than average stream flows throughout the watershed. 2019 riffle pebble counts had slightly higher % of fines compared to 2018 counts performed at the same site (**Figure 4, Appendix H**).

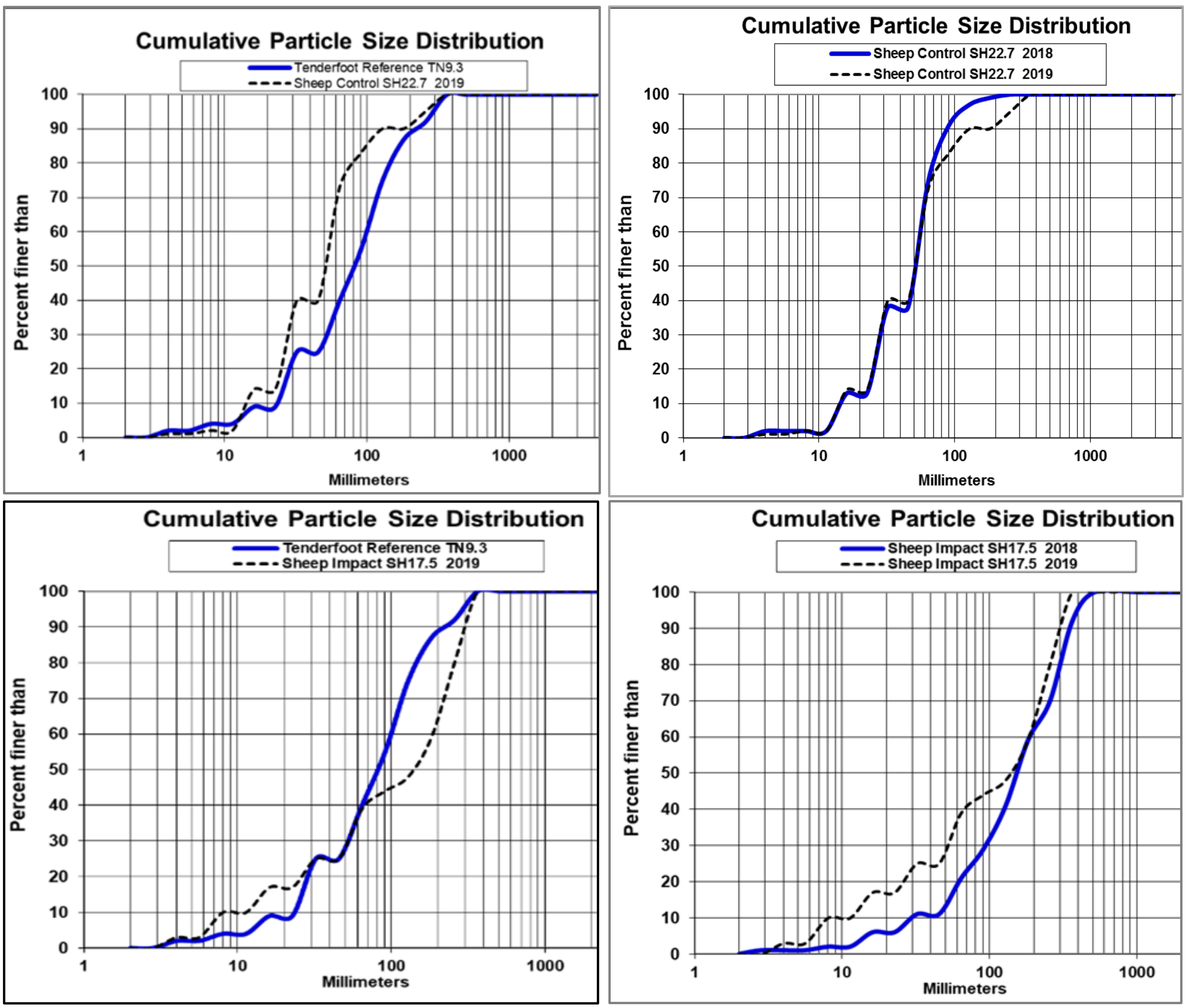
Figure 3. Sheep/Tenderfoot Creek (top) and Little Sheep (middle) % riffle fines (<6.3 mm) and Pool tail % fines (bottom) reported for the 2018 and 2019 grid tosses. Reference (R), Control (C) and Impact (I).





Most Sheep Creek Control and Impact sites had very similar pebble count profiles to Tenderfoot Creek (**Figure 4, Appendix H**); although, Little Sheep and Coon Creek had the highest percentage of fines in the pebble counts and Little Sheep LS.1 (I) had 10% benthic sediments <8mm, while Little Sheep LS.7 (C) had almost 50% of the benthic sediment in fines (<8mm) (**Figure 3, Appendix H**).

Figure 4. Sheep Creek Control (SH22.7) and Sheep Impact (SH17.5) vs. Tenderfoot Creek (left) and 2018 vs. 2019 (right) pebble count distributions.



3.3 FISH COMMUNITIES

Overall, we identified 9 fish species and 1 hybrid (6 native and 4 introduced) from >15,000 individuals collected during 96 seasonal stream reach surveys between 2014 and 2019 (**Table 2**). In 2019, we collected 1,753 individuals during 1 season (**Table 4**); while in 2017, we collected 6,177 individuals in 3 seasons (over 1,100 more individuals than in 2016) largely because of the new Moose Creek site and lengthened fish sampling reaches. Over the years, we have maintained incidental salmonid mortalities of less than 0.2% of stunned individuals. In 2017, we added two new native species, the mountain sucker (MOSU) (n=1), at SH15.5D (fall), and a >90% pure WCT (n=1) at TN9.3 (summer) to increase the total number of native fish species observed. Average number of fish species across the project area was 5.6 (± 0.47) per site, while native species averaged 2.0 (± 0.4 standard error [SE]). We collected fish during all surveys at all sites, except at Little Sheep Creek LS.7 during summer and fall of 2017 (**Figure 7**). Coon Creek (CN.5) was documented to be fishless in 2015 upstream of the county road, but downstream near its confluence with Sheep Creek, we collected juvenile <100 mm LOLE (n=4) and EBT (n=1) in summer 2016 while spot electro-fishing. The RMCOT comprised the highest proportion of total individuals collected (71%) and had 100% site occupancy (n=11 sites). Tenderfoot Creek had the highest percentage of sculpin comprising the catch (82%) due to their high abundance (**Table 4**, **Figure 11**). The other native species, mountain whitefish (MOWF), longnose dace (LNDA), white sucker (WHSU) and MOSU had site occupancy rates of 64%, 27%, 36% and 5%, respectively (**Appendix B**). This is a net increase in native fish site occupancy since 2016, despite adding 3 sites, because we documented WHSU and MOWF juveniles using Little Sheep Creek and capturing WHSU and LNDA at additional Sheep Creek sites (**Appendix B**).

The most diverse fish sites in the study area are Sheep Creek SH19.2 and SH15.5U/D reporting eight total species, and the highest number of native spp. (n=4) (**Appendix B**). No pure WCT were collected during any of the Sheep Creek surveys between 2014 and 2019, but we did collect, a phenotypically >90% pure WCT from the Tenderfoot Creek TN9.3 reach in 2017 and 2018 (**Photo 3**). RBT were collected at 10 of 11 sites in total, achieving highest average population densities at Moose Creek (687 per mile ± 496 SE) (n=4 surveys); TN9.3/TN9.4 sites had the next highest RBT + CTxRBT densities (330 per mile ± 84 SE) which was not significantly different from the SH17.5 avg. site, summer/fall RBT estimates (251 per mile ± 42 SE) (**Figure 7, Appendix B**). Over all survey years, average RBT densities at the 4 Sheep Creek impact sites (155 per mile ± 30 SE) (n=33), are significantly higher than in the 2 control sites (73 per mile ± 18 SE) (n=20) (ANOVA, p=0.001) and all RBT densities continue to decline, except at the lower SH15.5D/U sites (**Figure 7, red boxes**). EBT were collected at 9 of 11 sites in total, achieving highest average densities at Little Sheep Creek LS.1 (776 per mile ± 158 SE) (n=11 surveys) (**Figure 7**). EBT densities at both Little Sheep Creek sites (LS.1 and LS.7/AQ8) were on a significant upward trend since 2014, except in 2017, when EBT were not reported at Little Sheep Creek AQ8 site by the summer and fall (**Figure 3**). LOLE were detected at 7 of 11 sites, achieving highest densities at Sheep Creek sites SH19.2 and SH18.3 averaging ~87 per mile ± 13 SE. (**Figure 8**). MOWF were the most abundant and dominant salmonid species at Sheep Creek SH18.3 site (99 per mile ± 19 SE) (**Figure 4**), but were reported in very low numbers ~4.5 miles upstream at Sheep Creek SH22.7 in 2017 after collecting them there in 2014-2015 and absent in 2016 (**Figure 3**). LOLE and MOWF were never collected in the Tenderfoot Creek reaches which are above a natural barrier, and coincidently RMCOT densities and smaller size-classes of rainbow/hydrid trout were highest in this reach (**Figure 3, Appendix C**). Lowest trout densities and those of catchable size (>200mm) were reported from Sheep Creek SH22.7 and SH15.5D (**Figure 3, Appendix C**) where easily accessible fishing access may account for lower fish numbers through harvest or catch mortality.

Brushy Creek

In the spring of 2017, we collected 3 EBT (68-98 mm) within 40 m upstream of the proposed haul road culvert, while none were collected in 40m of electrofishing (360 seconds total) below the proposed road. Water temperature at this time was 5.0 °C with a conductivity of 264 µs/cm. During the summer, water was still present, but no fish were collected in this same reach using 400 seconds of electrofishing. Water temperature at this time was 18.0 °C with a conductivity of 320 µs/cm.

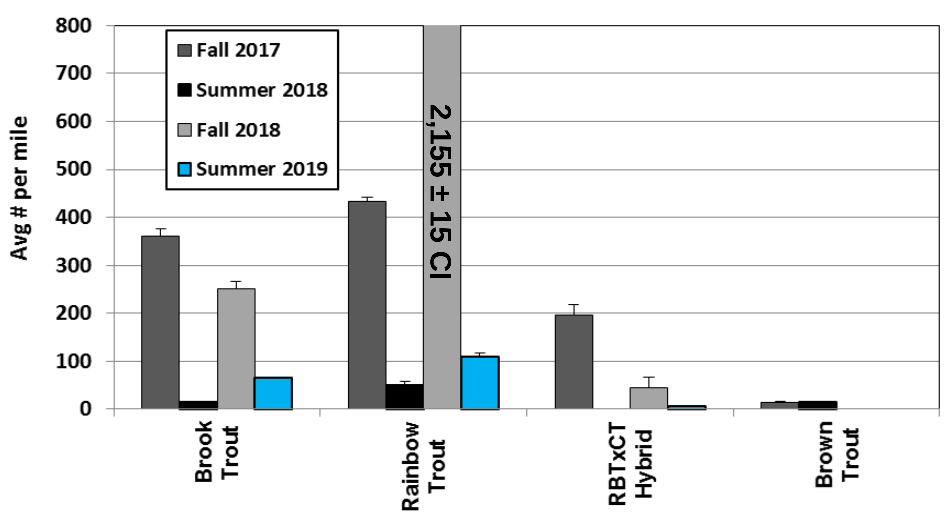
Little Sheep Creek (LS.7/AQ8, LS.6) Control

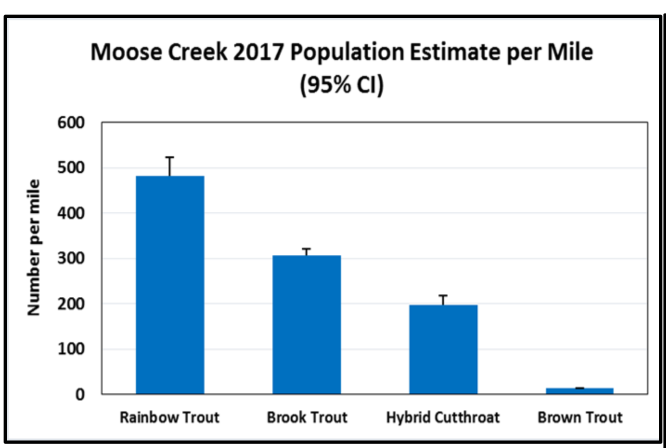
In the spring of 2017, we collected 6 EBT (125-305 mm) and 30 RMCOT (55-104 mm) in the 150 m long-term monitoring reach (**Map 1**, LS.7, old AQ8 site), but during the summer, zero EBT and 67 RMCOT (30-100 mm) were collected in the electrofishing survey (**Figure 3, Table 10**). The summer 2017 conditions in this reach of Little Sheep Creek were characterized by extremely low stream flows, warm temperatures (21.5℃ / 70.7℉) and a stream channel filled in with aquatic vegetation trapping sediment making sampling difficult. We postulate that EBT migrated out of this reach due to these degrading conditions. In the fall, we decided to move this monitoring reach ~1 km downstream to LS.6, which is upstream of the proposed haul road crossing (**Map 1**). During the fall sampling, no EBT and 42 RMCOT were collected in this new 150 m reach (**Table 2**). During summer of 2018, EBT were back in the LS.7 reach at densities and size classes typical of pre-2017 (104 ± 0 per mile, 95% CI). No EBT redds were observed in LS.7 or LS.6 during the October/November 2017, 2018 or 2019 redd surveys (**Figure 7**).

Moose Creek (MO.1) Reference

During the 2017 fall sampling period, we set up and 2-pass electro-fished a 210-m reach of Moose Creek with block seines beginning ~0.25 mile (400 m) upstream from the confluence with Sheep Creek. We captured 5 species of fish: EBT, RBT, CTxRBT, LOLE and RMCOT with RBT dominating the salmonid catch (43%) (**Table 4** and **Figure 5**). EBT were the 2nd dominant salmonid in the reach at 36%, followed by CT x RBT hybrids at 19% with low numbers of LOLE (n=2, 1.5%). Summer salmonid populations in 2018 and 2019 were very low at ~80 and ~182 total per mile, respectively (**Figure 5**). While during fall surveys of 2017 and 2018, salmonid population estimates significantly increased to 1,004 ± 60 trout per mile in 2017 and 2,451 ± 53 per mile (88% were RBT juveniles) (**Table 4, Figure 5**). This is ~3 times more abundant than adjacent Sheep Creek salmonid estimates for 2017 and 2018. Salmonids (EBT, RBT and CTxRBT) were dominated by 1st and 2nd year size-classes (~85% of individuals were <200 mm, smaller than catchable size) (**Figure 6, Appendix C**). Based on seasonal reductions in length frequencies of RBT from 2017 to 2018 and subsequent increases in RBT densities (125-150 mm) at Sheep Creek sites downstream of Moose (SH15.5U and SH15.5D), out-migration of the RBT 2nd year class is augmenting Sheep Creek populations. Moose Creek redd counts performed on Oct 25th, 2017 and Oct 23rd, 2018 contained EBT redds at densities of 0.67 and 0.4 per 100 m, respectively (**Figure 12**).

Figure 5. Moose Creek (MO.1) salmonid population estimates 2017-2019 in number per mile. Error bars are ± 95% CI





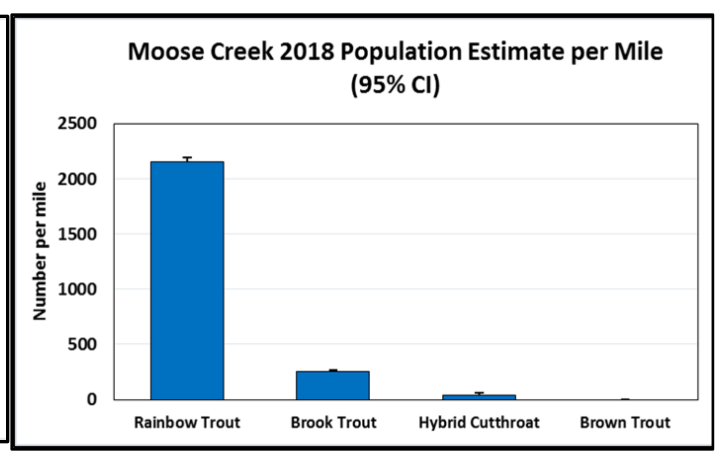


Figure 6. Moose Creek salmonid length frequencies for Fall 2017 (top left), Summer 2018 (top right), fall 2018, Summer 2019 (bottom right).

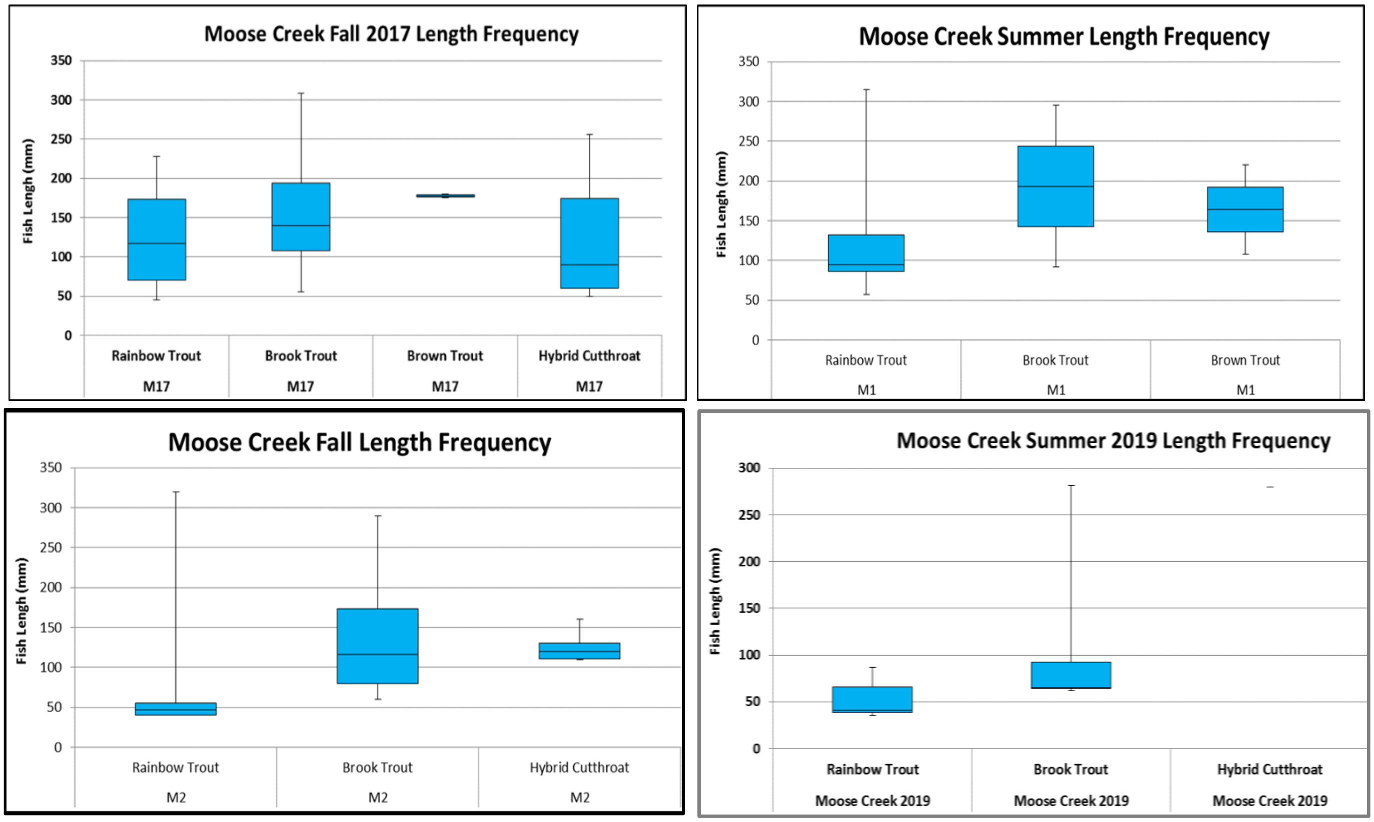


Table 4. Fisheries population data from BBC sites in 2019. Fish species were: EBT=brook trout, RBT=rainbow trout, LOLE=brown trout, CTxRBT= rainbow trout hybrid, MOWF = mountain whitefish, LNDA = longnose dace, WHSU = white sucker, RMCOT= Rocky Mountain sculpin. Population estimate (Pop. Est.). Average total length (L) and weight (W) and range.

Stream Section (survey length m)	E-Fish Survey Type	Shock Times (sec)	Species ID	July (#/reach)	July Pop. Est. #/mile (95% CI)	Avg. Ind. L (mm) (range)	Avg. Ind. Biomass (g) (range)
Little Sheep (LS.1)	2-Pass	1310	EBT	30	312 (291-333)	158 (100-280)	77 (20-221)
150m		720	RBT	2	21 (21-21)	201 (112-290)	114 (19-209)
			LOLE	8	83 (73-94)	190 (100-470)	443 (21-1410)
			RM COT	141	1,466 (6.4 per min.)	-	-
Little Sheep (LS.7)	2-Pass	788	EBT	6	63 (63-63)	195 (155-290)	168 (53-337)
150m		495	RM COT	48	499 (3.7 per min.)	65 (35-100)	4 (1-15)
Sheep (SH22.7)	M	2292	EBT	2	8 (6-10)	135 (105-165)	46 (22-69)
300m	RC	2692	RBT	4	42 (37-47)	143 (90-325)	162 (11-348)
			CTxRBT	3	16 (15-17)	269 (172-366)	170 (62-466)
			LOLE	6	47 (36-58)	244 (90-409)	250 (8-683)
			MWF	1	5	345	483.0
			RMCOT	130	676 (3.4 per min.)	-	-
Sheep (SH19.2)	2-Pass	2803	EBT	1	4 (4-4)	205	102
400m		2724	RBT	0	-	-	-
			CTxRBT	1	4 (4-4)	125	23
			LOLE	5	18 (14-20)	320 (180-370)	383 (88-510)
			MWF	7	25 (18-32)	310 (114-420)	371 (16-670)
			LNDA	6	21 (16-26)	82 (55-105)	7.9 (5-14)
			WHSU	2	7 (7-7)	186 (180-191)	87 (79-95)
			RMCOT	84	707 (3.0 per min.)	-	-
Sheep (SH18.3)	M	3298	RBT	5	28 (23-33)	239 (140-330)	212 (36-364)
450m	RC	3558	LOLE	10	47 (36-58)	265 (185-410)	287 (70-688)
			MWF	18	136 (125-146)	309 (200-430)	388 (108-726)
			CTxRBT	1	4	285	271
			WHSU	1	4	290	286
			RMCOT	141	733 (2.6 per min.)	-	-
Sheep (SH17.5)	M	2274	RBT	27	94 (80-108)	132 (92-220)	38 (13-117)
400m	RC	2371	CTxRBT	10	35 (29-41)	166 (120-220)	65 (28-124)
			LOLE	4	14 (12-16)	110 (100-122)	18 (14-22)
			EBT	1	4 (3-5)	216	117
			MWF	8	87 (74-100)	115	17
			RM COT	176	613 (4.6 per min.)	-	-
Sheep (SH15.5U)	2-Pass	2525	EBT	9	32 (25-39)	196 (150-237)	109 (56-145)
450m		1950	RBT	85	296 (216-376)	182 (85-310)	110 (9-290)
			CTxRBT	5	17 (12-22)	202 (137-285)	125 (56-212)
			LOLE	13	46 (42-49)	279 (105-460)	320 (20-825)
			MWF	51	178 (154-202)	224 (110-387)	186 (72-675)
			WHSU	1	4	230	210
			LNDA	7	25	115 (110-120)	19 (18-20)
			RM COT	128	892 (3.05 per min.)	-	-
Sheep (SH15.5D)	2-Pass	2482	EBT	4	14 (7-21)	186 (167-205)	79 (50-107)
400m		1821	RBT	55	192 (161-223)	191 (85-305)	121 (10-320)
			CTxRBT	2	8	144 (135-152)	77 (65-88)
			LOLE	10	35 (31-39)	261 (105-420)	270 (30-615)
			MWF	35	122 (101-143)	233 (112-360)	202 (25-580)
			WHSU	1	4	175	76
			LNDA	2	15.6	115 (110-120)	19 (18-20)
			RMCOT	115	401 (2.8 per min.)		
Moose (MO.1)	2-Pass	1503	EBT	9	66 (66-66)	97 (62-281)	35 (3-254)
210m		1230	RBT	15	109 (102-117)	51 (35-87)	3 (1-8)
			CTxRBT	1	7 (7-7)	280	186
			RM COT	125	1,027 (5.0 per min.)	-	-
Tenderfoot TN9.3	2-Pass	4266	EBT	7	37 (31-42)	150 (88-275)	63 (10-242)
400m		2275	RBT	0	-	-	-
			CTxRBT	27	140 (130-151)	168 (80-310)	70 (7-287)
			RMCOT	157	816 (2.2 per min.)		
Total Fish Collected				**1753**			

Figure 7. Seasonal salmonid abundance per mile (±95% CI) for SH22.7 (top), SH19.2 (middle) and SH18.3 (bottom) for the BBC sites. Arranged 2014-2019. Note scale differences on y-axis.

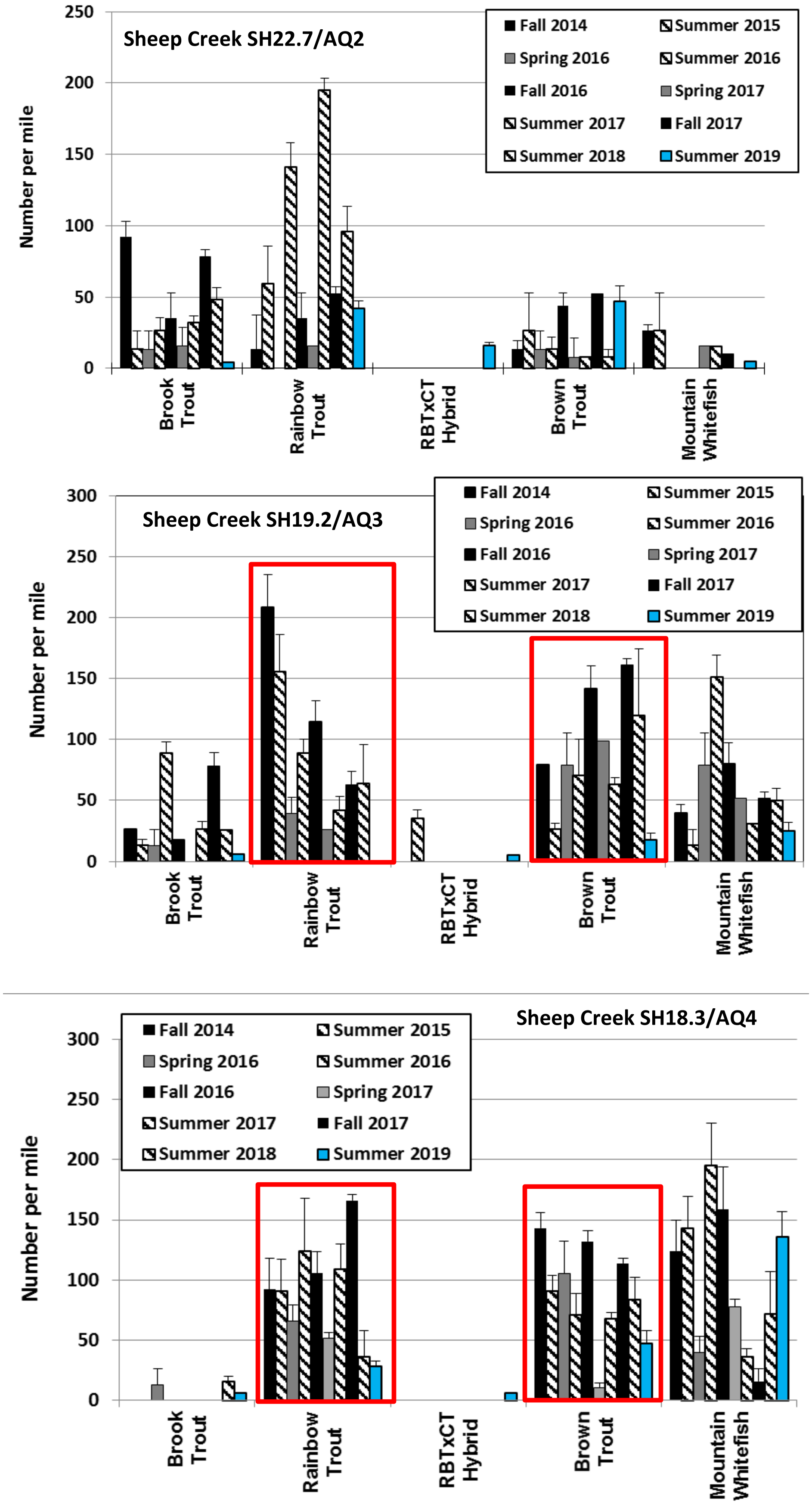
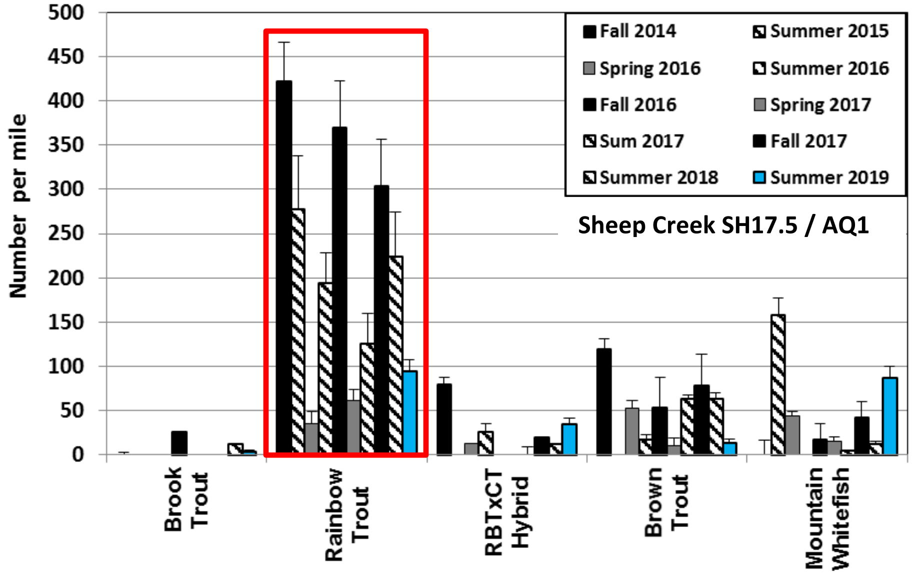
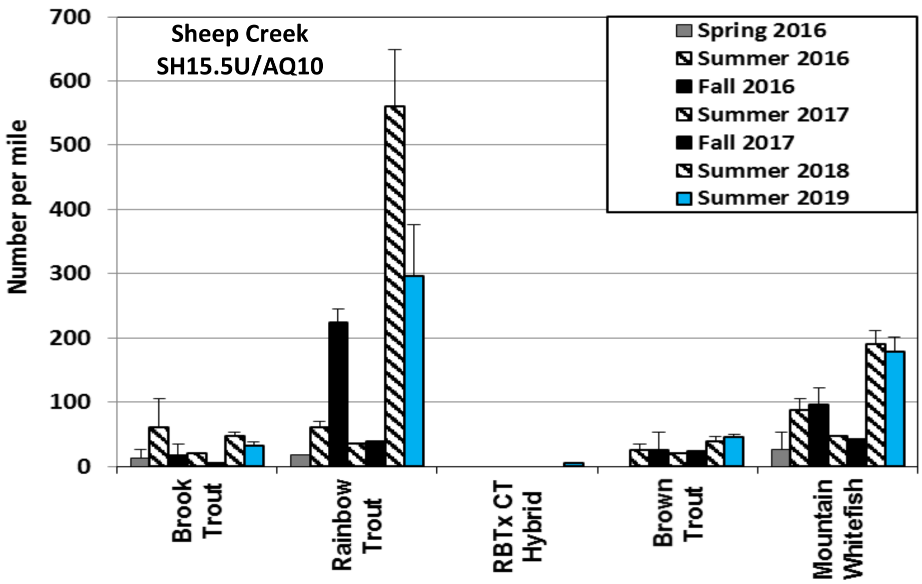


Figure 7 (cont.). Seasonal fish pop. estimates per mile (± 95% CI) for Sheep Creek SH17.5 (top), and SH15.5U (middle) and SH15.5D (bottom). Arranged 2014-2019. Note scale differences on y-axis.





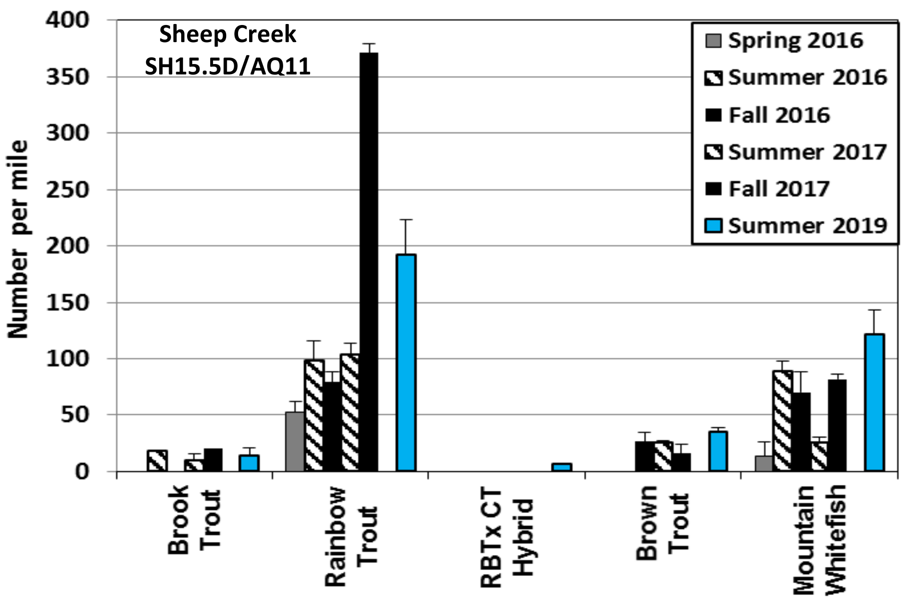
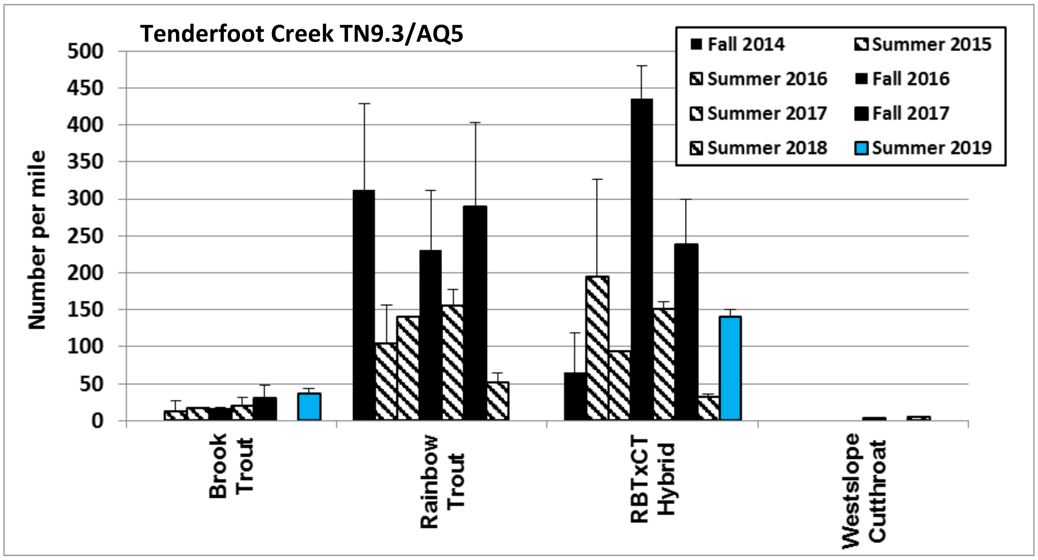
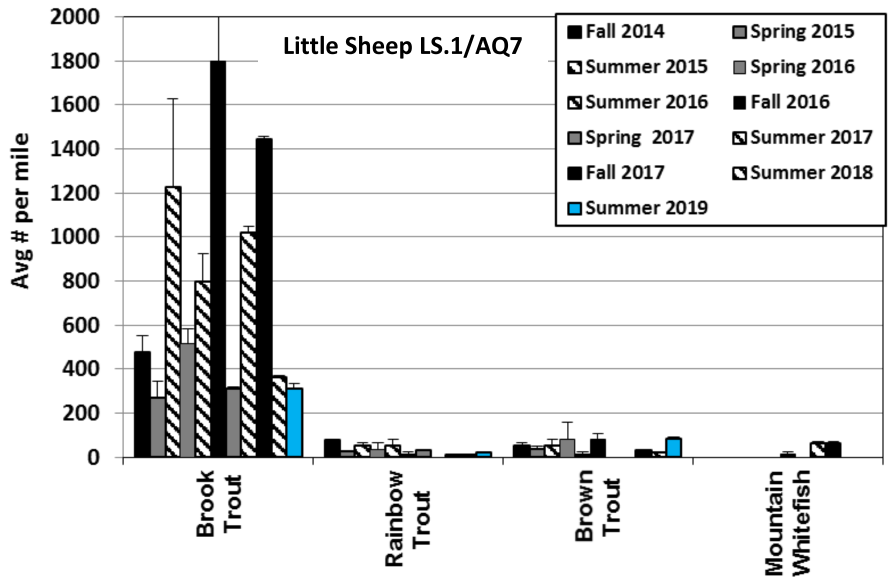


Figure 7 (cont.). Seasonal salmonid pop. estimates per mile (±95% CI) for TN9.3/9.4 (top) Little Sheep Creek LS.1 (middle) and LS.7/ AQ8 (bottom). Note differences on y-axis. *Red box = no fish captured*.





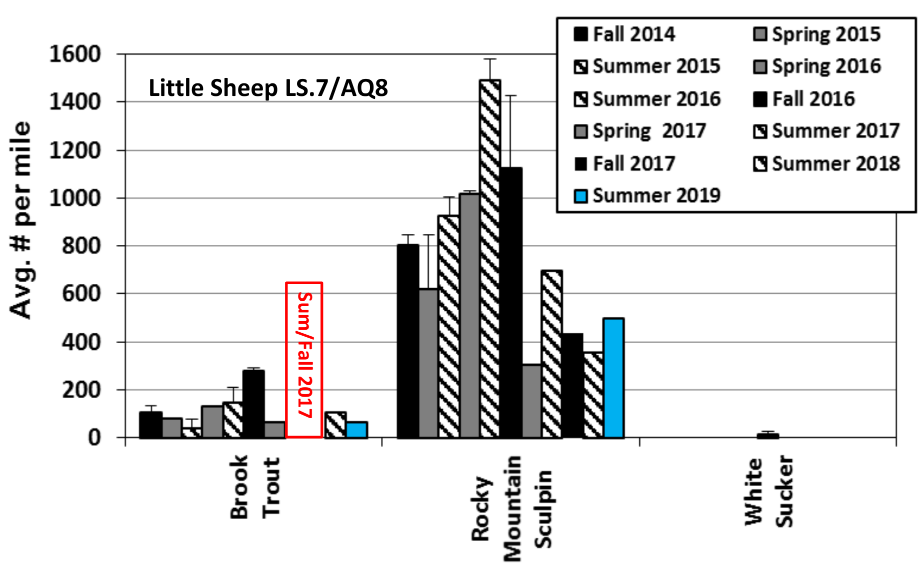
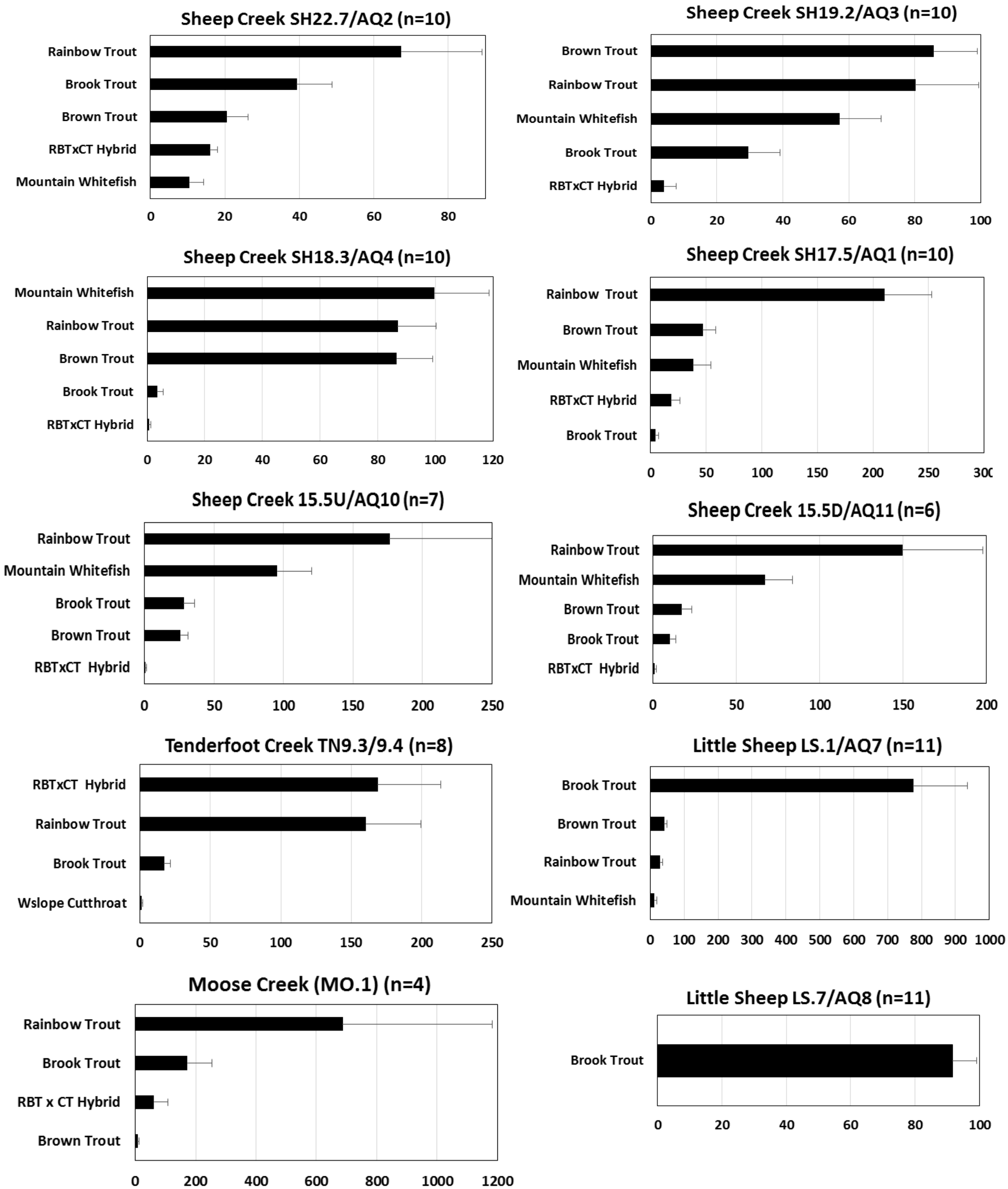


Figure 8. Overall average salmonid abundance per mile (±SE) for Sheep, Little Sheep, Moose, and Tenderfoot Creek sites across all seasonal surveys 2014-2019 (n). *Note scale differences on x-axis.*



Seasonally, fall population estimates (2014-2017), across most sites, were higher than the summer population estimates (except RBT in SH22.7) (**Figure 7**). But, decreasing salmonid abundance trends in the BBC meadow reaches, Little Sheep Creek sites and the canyon impact reach (SH17.5) are very real regardless of sampling season (**Figure 7**). Only the lower impact reaches (SH15.5U/SH15.5D) are exhibiting increasing population densities for RBT and MOWF (**Figure 7**). RBT or CTxRBT hybrids (in TN9.3/9.4) were the dominant species at 7 of the 11 monitoring reaches, LOLE and MOWF are still dominant in the meadow reaches, SH19.2 and SH18.3, respectively (**Figure 8**).

Sheep Creek Control (SH22.7)

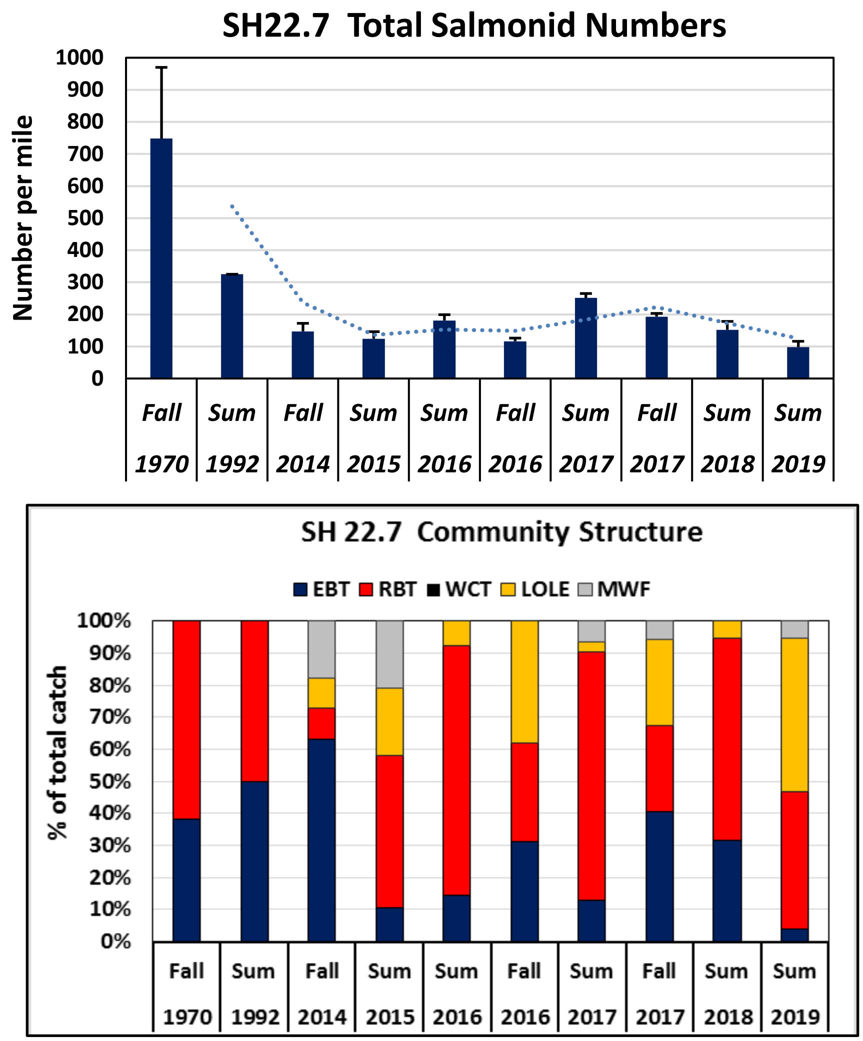
Total salmonid (EBT, LOLE, MOWF and RBT) abundance estimates at SH22.7 (avg. 158 per mile ± 18 SE) for the past 6 years were significantly lower than the 1970 and 1992 estimates of 748 and 325 per mile, respectively (MFWP 1973, MFWP 2014) (**Table 5**, **Figure 9**). No WCT were reported at this site between 2014 and 2019, but they were in 1970, while MOWF and LOLE were not reported in 1970 or 1992 but are currently present in good numbers (**Table 5, Figure 9**).

Table 5. *Current and historical population estimates (Pop. Est.) numbers per mile (±95% CI) reported for the control site SH22.7. NR = not reported.*

Year	1970	1992	2014	2015	2016	2016	2017	2017	2018	2019
Species	**Fall**	**Summer**	**Fall**	**Summer**	**Summer**	**Fall**	**Summer**	**Fall**	**Summer**	**Summer**
EBT	286 (208-364)	NR	93 (73-113)	13	26	36 (31-41)	32 (27-37)	78 (73-83)	48 (40-56)	4 (3-5)
RBT	462 (342-582)	NR	14	59 (54-64)	141 (131-151)	36	195 (187-202)*	52 (47-57)	96 (78-122)	42 (37-47)
WCT	2	NR	0	0	0	0	0	0	0	0
LOLE	0	NR	14	26	14	44 (34-54)	8	52	8	47 (36-58)
MOWF	0	NR	26	26	0	0	16	11	0	5
Total	**748**	**325**	**147**	**124**	**181**	**116**	**251**	**193**	**152**	**98**

*** 91% were juveniles <50mm**

Figure 9. *Historical and current salmonid densities (top) and composition(bottom) for SH22.7 (C). 1992 reported as pers. comm with L. Walch, retired USFS biologist, 2018. Dotted line is the moving average.*



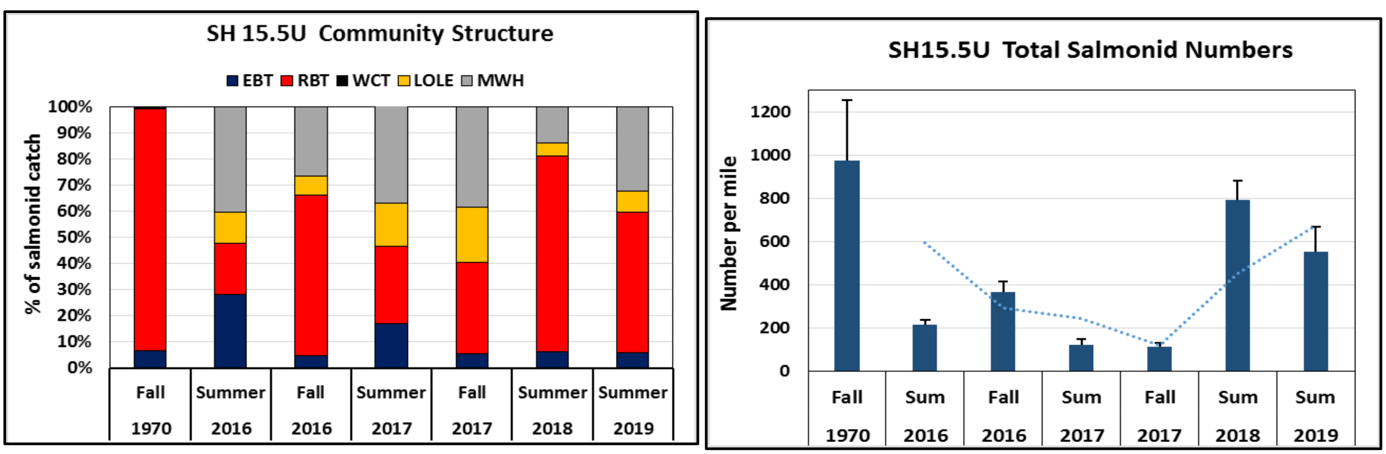
Sheep Creek Impact (SH15.5U) at FAS

The downstream impact sites SH15.5U and SH15.5D had fish communities similar to SH18.3, SH19.2 and SH22.7 (**Figure 4**), but with fewer LOLE and recent increasing trends of RBT densities. These sites, which qualitatively have similar pool habitat, also reported fewer catchable-sized fish (>200 mm) than we found in the Sheep Creek meadow reaches SH19.2 and SH18.3 (**Appendix C**). We observed similar patterns at the control site SH22.7 which has roadside fishing access, and likely higher fishing pressure. Total salmonid abundance at site SH15.5U (closest to Moose Creek) reported significantly fewer fish between 2016 and 2018 than surveys performed near this reach in 1970; no WCT were reported at this site between 2016 and 2019, as they were in 1970; LOLE and MOWF densities are on increasing trends between 2016 and 2019, neither species was reported in 1970 (**Table 6, Figure 11**). We observed significant increases in RBT densities at sites SH15.5D (AQ11) in 2017 and SH15.5U (AQ10) site in 2018, especially in the 150-200 mm size classes (**Appendix C**).

Table 6. *Current and historical population estimates (Pop. Est.) numbers per mile (±95% CI) reported for the impact site SH15.5U.*

Year	1970	2016	2016	2017	2017	2018	2019
Species	**Fall**	**Summer**	**Fall**	**Summer**	**Fall**	**Summer**	**Summer**
EBT	64	62	18	21 (11-31)	6	35 (30-40)	32 (25-39)
RBT	901	62 (57-67)	224 (203-245)	37 (31-42)	39 (31-47)	595 (472-648)	296 (216-376)
WCT	8	0	0	0	0	0	0
LOLE	0	26	26	21 (20-21)	24 (20-28)	39 (31-47)	46 (42-49)
MWH	0	88 (78-98)	96.8 (72-112)	47 (42-52)	43 (35-51)	112 (102-122)	178 (154-202)
Total	**973**	**238**	**365**	**125**	**112**	**794**	**552**

Figure 10. Historical and current salmonid composition (left) and total abundance per mile (±95% CI) (right) for Sheep Creek SH15.5U FAS impact site. *Dotted line is the moving average*

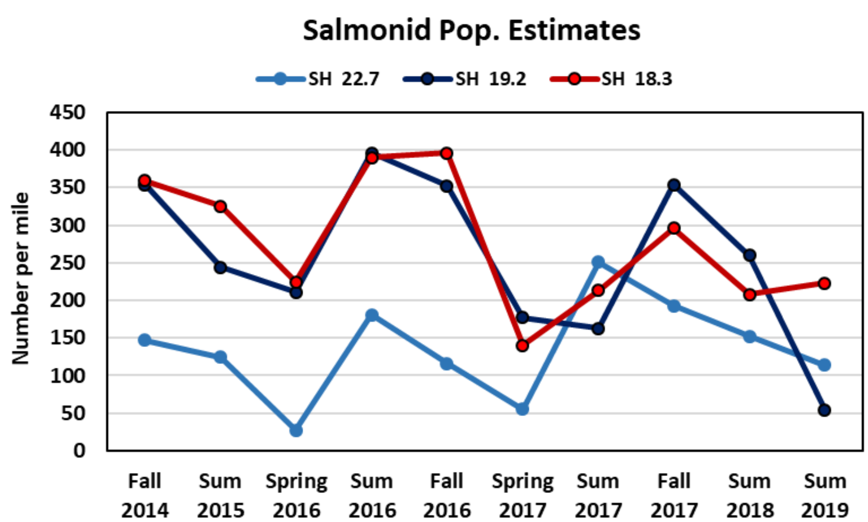


Total salmonid densities at this site in 2018 were approaching 1970 densities (**Table 6**), but with a different community structure (**Figure 10**). We attribute this increase in RBT densities to a large recruitment of Year 1 and 2 juvenile RBT out-migrating from Moose Creek approximately ½-1 mile upstream from these sites (**Figure 6**). RBT size-frequency numbers indicate the presence of four dominant size-classes (age classes) across most Sheep Creek reaches, except those with abundant large LOLE where the 1st and 2nd year classes (<100 mm) are missing (**Appendix C**), likely due to predation. The most evenly distributed RBT size-classes were observed during summer and fall at the Tenderfoot Creek TN9.3 and Sheep Creek SH19.2 sites (**Appendix C**).

LOLE size classes are eschewed towards larger fish across most Sheep Creek sites, especially at SH15.5U (**Appendix C**). The most evenly distributed LOLE size-class populations were observed during the summer and fall at the meadow SH19.2 and SH18.3 sites (**Appendix C**). This appears to be indicating that recruitment of younger age-class LOLE into those reach populations coming from nearby refuge areas (e.g. Little Sheep Creek, Spring Creek). The most evenly distributed EBT size-class populations were observed during spring surveys at Little Sheep Creek LS.7/AQ8, and during the fall at the Little Sheep Creek LS.1 site (**Appendix C**). Large numbers of juvenile EBT (<100 mm) were observed at Little Sheep LS.1 in the summer of 2016 and 2017 indicating the successful recruitment of this size-class from the previous year's spawn (**Appendix C**). MOWF juveniles were observed across most Sheep Creek sites, except SH22.7 and LS.1 in the spring and summer surveys (**Appendix B**).

Baseline "pre-impact" salmonid abundance data between the SH19.2 control site and the SH18.3 impact was tracking very closely until 2019, when SH19.2 salmonid numbers crashed **(Figure 11**). These multiple years of baseline data over a range of sites, climatic and stream flow patterns are truly needed to document patterns and natural seasonal variability of the aquatic communities.

Figure 11. Total salmonid population estimates through the study period for two Sheep Creek upstream control sites (SH22.7 and SH19.2) and the first impact site (SH18.3).



Rocky Mountain Sculpin (RMCOT)

We revised previously estimated populations of the RMCOT based on single pass depletion of the whole reach (instead of sections) and report catch per unit effort (CPUE) (**Table 4, Figure 13**). Highest population estimates for Sheep Creek sites were reported in 2014 and 2015 (avg. 2,290 per mile), while highest populations in Tenderfoot Creek were recorded over 2014-2016 (avg. 4,979 per mile); Little Sheep sites avg. 962 per mile during this period (**Figure 12**). Sculpin densities decreased and then stabilized at the upper 4 Sheep sites between 2016 and 2018 (~1,200 per mile) at significantly lower estimates than 2014-2015 (T-test, p=0.002) (**Figure 12**). RMCOT population estimates in 2019 were the lowest yet, averaging ~670 per mile across the 6 Sheep Creek sites (**Figure 12**). RMCOT CPUE numbers from 2014 and 2015 are not significantly higher than 2016-2017 (T-test, p=0.11), but 2018 and 2019 CPUE are significantly lower (T-Test, p=0.02). Stable densities in Little Sheep Creek LS.1 from 2014 to 2017 (avg. 950 per mile), appeared to take a significant dip in 2018 (avg. 364 per mile), then rebound in 2019. A steady decline in the LS.7 RMCOT numbers between 2016 and 2019 was observed, likely due to the high temperatures and weed growth of 2017. Possibly inflated RMCOT population estimates for Sheep Creek 2014 and 2015 may be due to extrapolations from shorter reach lengths, but this does not explain higher CPUEs, and similar high population estimates obtained with longer reach lengths in TN9.3, then similar subsequent declines. These population declines of RMCOT in the Sheep Creek and Tenderfoot Creek reaches are substantial and may be coincidental with higher average stream flows, but not likely (**Figure 13**).

Figure 12. Total annual sculpin population estimates (top) and CPUE (number per minute of shock time) (bottom) through the study period for BBC Sheep Creek sites.

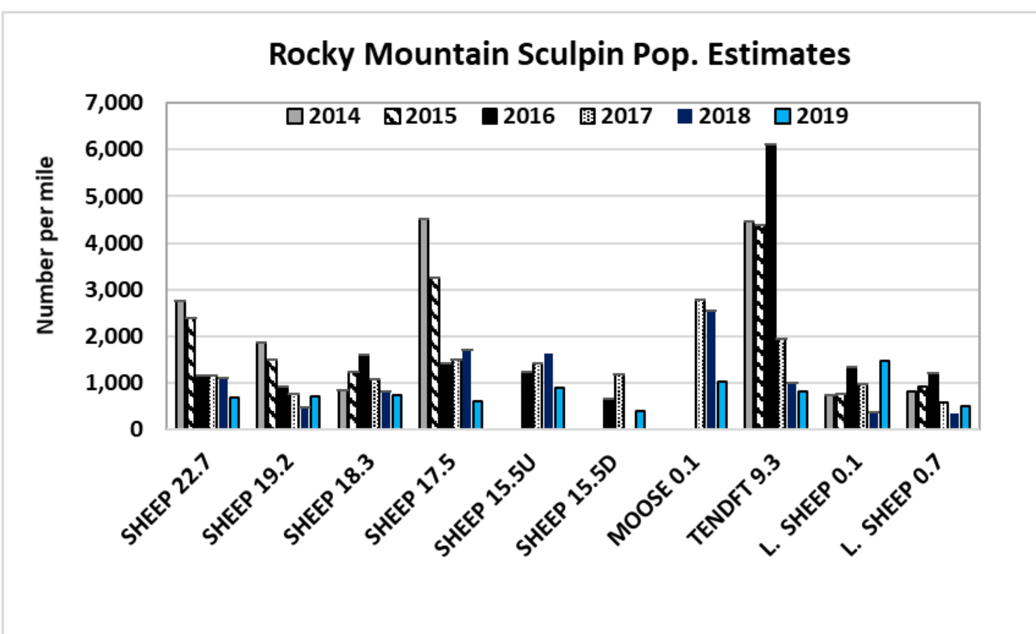
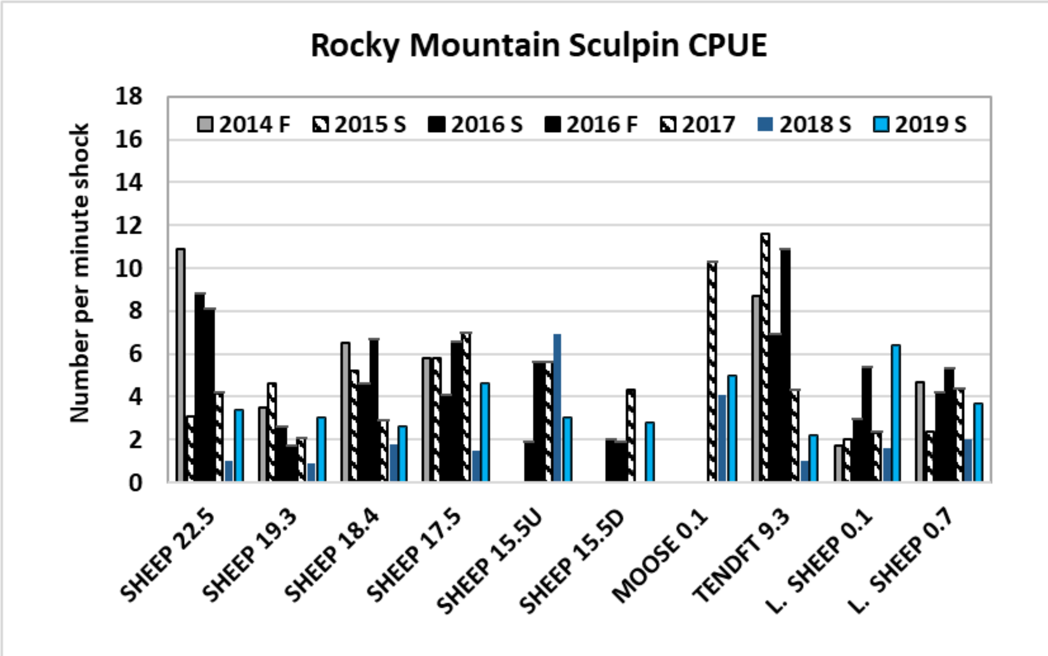


Figure 12. *cont*. Total annual sculpin population estimates (top) and CPUE (number per minute of shock time) (bottom) through the study period for BBC Sheep Creek sites.



3.3.1 Pit Tagged Fish

We captured and released 11 pit-tagged fish (2 recaptures) from the MSU/MFWP study during the 2016 summer and fall surveys, none were reported in spring of 2016 (**Table 7**). No pit-tagged fish were identified at any site during any season between 2017 and 2019. The MOWF captured at SH19.2 (AQ3) in the summer of 2016 was the furthest upstream detection of any tagged fish into the BBC Project Area (**Table 7; yellow shading**). Pit-tagged-fish captured by our crew at SH17.5 (AQ1) during the summer 2016 surveys were recently tagged at that location (**Table 7**, M. Lance, pers. comm.), and showed signs of recent handling stress (i.e. missing scales, poor condition). The recaptured MOWF at SH18.3/AQ4 and RBT at SH15.5U/AQ10 identified during the summer, then fall surveys, presumably spent 60-70 days in that reach or nearby; both individuals appeared to be healthy and have gained weight since the initial capture (**Table 7**).

Table 7. Location, date and species of pit-tagged salmonids within the Sheep Creek monitoring reaches. No pit-tags were reported in 2017-2019. RBT= rainbow trout, LOLE=brown trout and MOWF= mountain whitefish. Yellow shading are fish upstream of the USFS boundary in the BBC mine permit area.

Site ID	RM	Date	Species	Length (mm)	Weight (g)	Pit-Tag ID
AQ3	SH19.4	7/12/2016	MOWF	265	185	2280 00117390
AQ4	SH18.3	7/13/2016	MOWF	290	250	982 05538110
AQ4	SH18.3	7/13/2016	MOWF	305	285	2280 00177495
AQ4	SH18.3	7/13/2016	MOWF	305	225	982 05538165
AQ4	SH18.3	9/20/2016	MOWF	307	266	982 05538165
AQ1	SH17.5	7/13/2016	RBT	220	110	982 05538116
AQ1	SH17.5	7/13/2016	RBT	280	220	2280 00148400
AQ1	SH17.5	7/13/2016	RBT	270	229	2280 00177193
AQ1	SH17.5	7/13/2016	LOLE	270	208	982 05538112
AQ1	SH17.5	7/13/2016	RBT	265	218	982 05538076
AQ10	SH15.5U	7/14/2016	MOWF	305	347	2280 00177470
AQ10	SH15.5U	7/14/2016	RBT	270	192	2280 0011667
AQ10	SH15.5U	9/20/2016	RBT	275	210	2280 0011667

3.3.2 Fish Anomalies

We documented opercula erosion (OR) in a small percentage (~10%) of the EBT in Little Sheep Creek in 2014, 2015 and 2016 (**Photo 3**). The number of EBT affected by OR in 2017 increased to 17% at LS.1, and OR infections were initially reported at 10% of EBT captured in Moose Creek (Fall 2017). We also documented 3 of 5 (60%) of the EBT collected at SH15.5D affected by OR in 2017. Similar percentages of OR were reported for EBT in 2018 (19%) and 2019 (18%) in LS.1, and 9% at Moose Creek. We have not observed this condition in any other salmonid captured during the study.

This condition can be caused by bacterial gill disease (BGD), so that when gills swell, the gill cover quickly erodes away; typically, only one of the two gill covers is eroded ~20-40%. Oftentimes found in hatcheries, or in the wild, when organic loading into the stream is occurring, the numbers of bacteria can be exceedingly high and can cause similar symptoms on the gills (swelling, mucus etc.) (Klontz 1979). High loads of *E. coli* bacteria documented in Sheep Creek and tributaries (DEQ 2017) may be contributing factors. Based on macroinvertebrate and periphyton metrics, nutrient loading is still occurring in Little Sheep Creek, but may be improving. Chromatophore EBT were also sporadically collected in the Little Sheep Creek sites; only 2 individuals have been collected since the start of the study in 2014 (see Stagliano 2018 for photo).

Photo 3. Stage I opercula reduction (OR) in a juvenile brook trout (left) and severe Stage II OR in adult EBT (red circles) both collected in Little Sheep Creek LS.1.

3.3.3 Fish Tissue Analysis

RMCOT (n=5 per site) exhibited one significant difference in tissue metals values (Manganese in 2017) between sites upstream (C) and downstream (I) of the BBC Project Area (**Table 8**); no other metals exhibited control vs. impact site differences; although, RMCOT aluminum levels in 2019 at the Sheep Creek FAS (SH15.5U) was 3 to 4 times higher than the other sites (**Table 8**). There were some notable between-year differences; 2017 iron levels were significantly lower than 2018 levels across all sites (T-test, p=0.04), and 4 of 5 tissue samples were non-detect for selenium in 2017 and 2018 compared to low levels in all 4 2016 samples (**Table 8**). Iron values appeared initially high in the Little Sheep Creek RMCOT tissues in 2016, but these reported a significant reduction in 2017, EBT juveniles from the same site reported much lower values (**Table 8**). The reported tissue levels for all metals are below the impairment threshold for Aquatic Life Standards (DEQ 2012a). Arsenic, cadmium, lead, mercury and nickel were not reported at detectable levels at any site by Energy Laboratories analysis between 2016 and 2019 (**Appendix F**).

Table 8. Baseline tissue metal values (mg/kg) for (Aluminum (AL), Copper (CU), Iron (FE), Manganese (MN), Selenium (SE), Zinc (ZN) from sculpin and juvenile EBT downstream (I) and upstream (C) of the BBC Project Area. ND= non-detectable at reporting limits

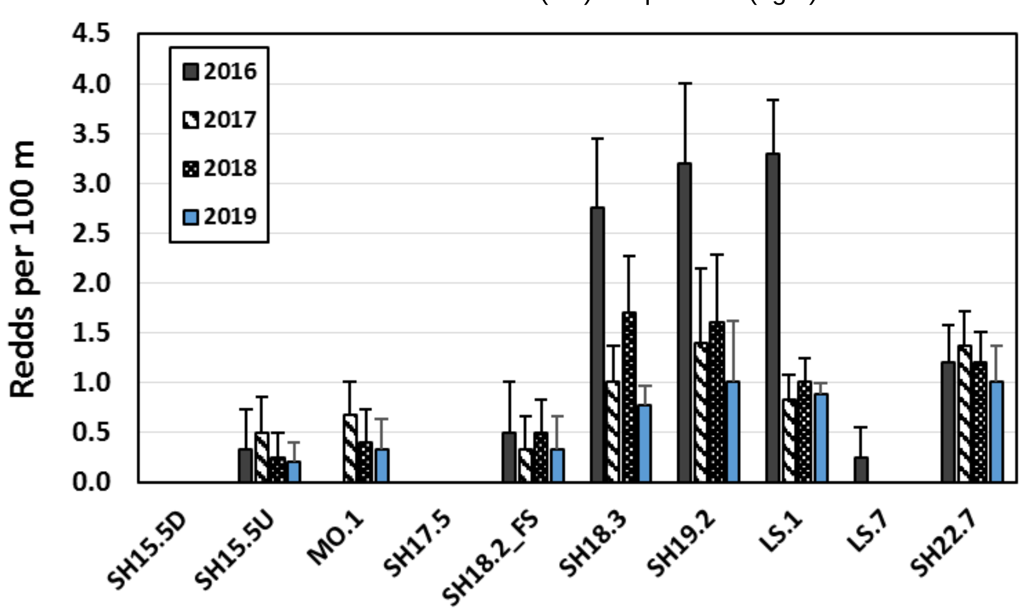
Metal Element	AL		CU				FE		MN			SE				ZN			
Stream Site	2018	2019	2016	2017	2018	2019	2016	2017	2016	2017	2019	2016	2017	2018	2019	2016	2017	2018	2019
Sheep SH15.5 (I)		134				1					9				ND				31
Sheep SH17.5 (I)	29	28	2	1	ND	ND	204	53	8	9	8	1	ND	ND	ND	25	20	21	22
Sheep SH18.3 (I)	15	13	1	1	ND	ND	177	43	4	11	4	3	ND	ND	ND	18	27	17	13
Average:	22.0	58.3	1.5	1.0	ND	1	190.5	48.0	6.0	10.0	6.0	2.0	ND	ND	ND	21.5	23.5	19.0	22.0
Sheep SH22.7 (C)	25	46	1	1	ND	ND	171	24	7	6	10	2	ND	ND	ND	22	20	16	22
L. Sheep LS.1 (C)	23	42	1	ND	ND	ND	275	155	8	5	5	2	1	2	2	24	23	21	21
L. Sheep LS.1 (C)(EB)				1	ND			23		3			ND	ND			22	22	
Moose MO.1 (R)		40				ND					5				ND				18
Average:	24.0	42.7	1.0	0.7			223.0	67.3	7.5	4.7	7.5	2.0	0.3	0.7	0.7	23.0	21.7	19.7	20.3
T-test, p-value (C x I)	0.4	0.35	0.21	0.25			0.32	0.38	0.27	0.03		0.50	0.25	0.25		0.36	0.28	0.41	0.41
F-test, p-value (year)	0.002		0.06				0.04		0.49			0.07				0.47	0.08	0.07	0.07

3.3.4 Spawning Redd Counts

In 2017, 2018 and 2019, we evaluated approximately ~3.2 miles (4,900 m) of stream channel, and 2.8 miles (4,500 m) in 2016, encompassing all Sheep Creek and Little Sheep Creek monitoring sections for the presence of trout spawning redds during the last weeks in October into November. LOLE spawn early in Sheep Creek within the BBC project area. Redd count tallies reported on Oct 23-26th (2016-2019) were typically the same as revisit counts on Oct 31-Nov 11th (**Appendix J**). High spawning site fidelity has also been documented between years. Anchor ice began to form by mid-November during most years concluding the spawn (Nov. 11th in 2019, cover photo). EBT redds averaged 3.3 and 0.25 per 100 m in 2016 at Little Sheep Creek LS.1 and LS.7, respectively (**Figure 13**). In 2017, EBT redds at LS.1 were less than ⅓ those densities, and no redds were observed in LS.7; no redds have been observed in the LS.6/LS.7 reach since 2016 (**Figure 13**).

Moose Creek (MO.1) redd counts (added in 2017) contained EBT redds at densities of less than 1 per 100 m during all years surveyed (**Figure 13**). The highest number of LOLE redds, averaging 3.3 and 2.8 per 100 m, were reported in 2016 at sites SH19.2 and SH18.3, respectively (**Figure 13, Map 2**). These redd counts extrapolated to ~53 and 48 per mile in 2016 (**Figure 13**). Redd counts at these same sites between 2017 and 2019 were less than ½ of those densities reported in 2016 and continue to decline (**Figure 13**). Very few LOLE redds (3 in total) were observed below the BBC/USFS boundary reach downstream of the lower meadow reach (SH18.3) with only one of these occurring in the lower 3 monitoring reaches (SH17.5, SH15.5U, SH15.5D) (**Map 2**). Spring redd counts at all Sheep Creek and Little Sheep Creek sites in late-April and early-May reported zero RBT redds in both 2018 and 2019. Moose Creek reported one RBT spring redd in 2018 and 2 redds in 2019 in the lower 600 m of this stream (**Appendix J**).

Figure 13. Average number of redds per 100 m at sites within the BBC project area. Sites arranged from furthest downstream (left) to upstream (right).



Map 2. Redd count locations with 2016-2019 Fall and Spring numbers highlighted for monitoring sites in the BBC project area.

3.5 FRESHWATER MUSSEL SURVEYS

No evidence of the WEPE (live, dead, or shell fragments indicative of a previous historical population) was reported during the 2014 and 2016 standardized surveys of Sheep, Little Sheep or Tenderfoot Creek reaches or during any subsequent aquatic surveys in the project area.

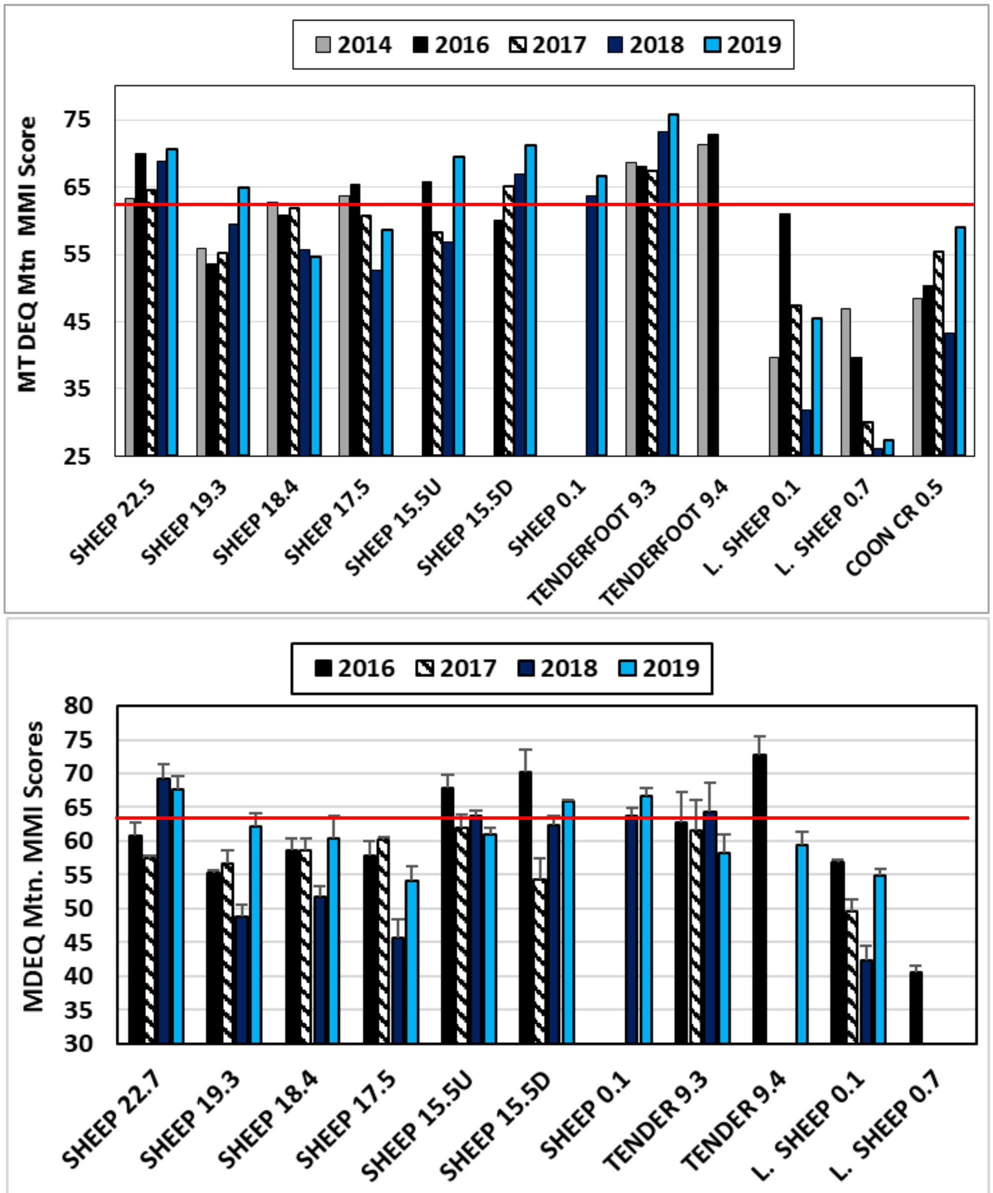
3.6 MACROINVERTEBRATE COMMUNITIES

3.6.1 Sheep / Little Sheep / Tenderfoot / Coon Creek sites

Overall, 148 unique macroinvertebrate taxa were reported from the 170 assessment samples collected from the BBC Project streams from 2014 to 2019 (**Appendix D**). No Montana invertebrate SOCs were collected. The macroinvertebrate community at the control site Sheep Creek SH22.7 had high benthic densities, EPT taxa and DEQ mountain MMI scores that resembled the community of the reference stream (Tenderfoot Creek) (**Table 7, Figure 14**). Sheep Creek SH18.3 reported the highest taxa richness (64 spp.), while SH22.7 had the highest number of combined mayfly, caddisfly and stonefly taxa (EPT) (29 species) in 2017, while 30 EPT taxa were reported in SH15.5U in 2016 (**Figure 17**). Tenderfoot Creek reported the highest integrity scores ranked by the DEQ MTN MMI (avg. 70), while Sheep Creek sites averaged 61.6, which is ranked slightly impaired by DEQ thresholds. 2016 MMI differences are not significantly lower (ANOVA, p=0.22) than they were in 2014 (**Appendix D**). Control Sheep Creek sites (SH22.7 and SH19.2) had lower overall macroinvertebrate integrity measured by the MMI (avg. 60.4) than the treatment reaches (SH17.5, SH18.3, SH15.5U, SH15.5D) (avg. 62.4), but this was not significantly different (T-test, p=0.25). Initial 2014 macroinvertebrate densities were highest in Tenderfoot Creek and were significantly higher than Sheep or Little Sheep Creek (one-way ANOVA, p=0.03 and 0.028, respectively); this was not significant in 2016 (**Table 9**). Average macroinvertebrate richness across all sites was 46 taxa, while EPT taxa averaged 20 per site (**Figure 17**). EPT taxa and % EPT were not different between Sheep Creek and Tenderfoot Creeks in 2016, but Little Sheep Creek and Coon Creek had significantly lower values than both other sites (**Table 7**). Both Little Sheep Creek sites and Coon Creek were ranked impaired by the DEQ Mtn. MMI with scores <63 in all years and should probably be evaluated with the Low Valley MMI as well (**Figure 14**). All project site macroinvertebrate communities scored above the impairment threshold of the Low Valley MMI in 2019, except Little Sheep Creek LS.7/AQ8 and both Little Sheep Creek sites in 2017, 2018 (**Figure 14, 15, 16 & 17**). Coon Creek is exhibiting an upward trend in macroinvertebrate integrity scores between 2014 and 2019, other than a decline in 2018 (**Figure 13**). It is notable that control site SH19.3 was reporting significantly different (lower) macroinvertebrate MMI scores than the Tenderfoot Creek reference sites in 2014-2017, but has rebounded in 2019 (**Figure 13**,

Appendix D). DEQ MMI Scores from the Hess samples are typically scoring lower than RW samples, exceptions being the impact sites SH15.5U and 15.5D in 2016-2018 and LS.1 in 2018 (**Figure 16**).

Figure 14. Macroinvertebrate EMAP Reach-wide (RW) (top) and Hess (n=3) (bottom) DEQ Mountain MMI scores for BBC sites arranged U/S to D/S. Red line represents the impairment threshold (63), below this indicates impairment.



Across most sites, macroinvertebrate Hess sample DEQ Mtn. MMIs from 2016 to 2019 reported lower scores of biological integrity than were reported for the RW macroinvertebrate samples (**Figures 14-17**), except at Sheep Creek 15.5D where the Hess samples scored substantially higher than the RW samples in 2016 and 2018. Likewise, for the DEQ LVal MMI scores at Sheep 15.5U and 15.5D (**Figure 15**). Hess samples collected at Sheep Creek sites SH19.3, SH18.3 and SH17.5 scored lower than the DEQ Mtn. MMI impairment thresholds in all years (2016-2019) (**Figure 15**).

Figure 15. 2016 DEQ Mountain (left) and Low Valley (right) MMI scores calculated for the Reach-Wide (RW) vs. Hess samples (n=3). Red line in the impairment threshold.

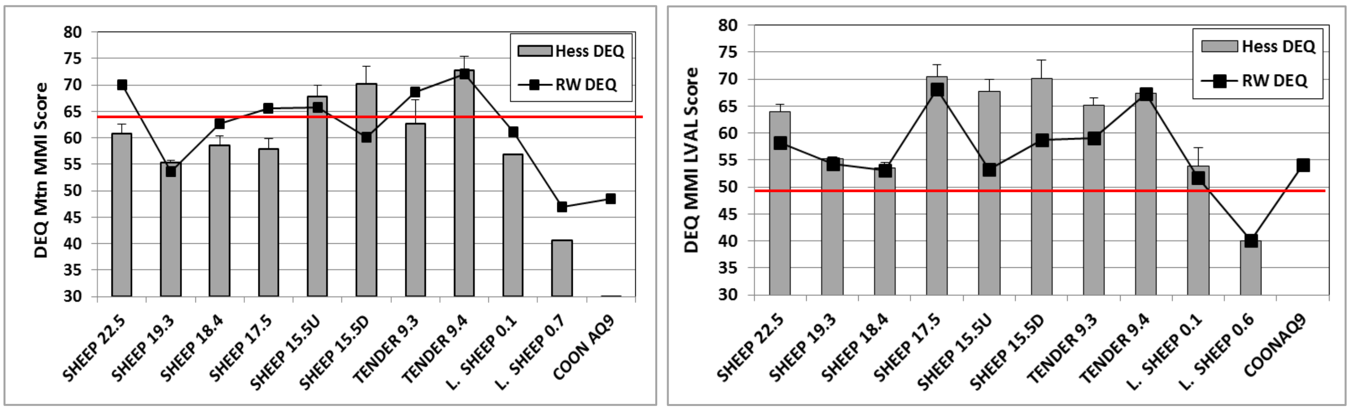


Figure 16. 2017 DEQ Mountain (left) and Low Valley (right) MMI scores calculated for the Reach-Wide (RW) vs. Hess samples (n=3). Red line in the impairment threshold.

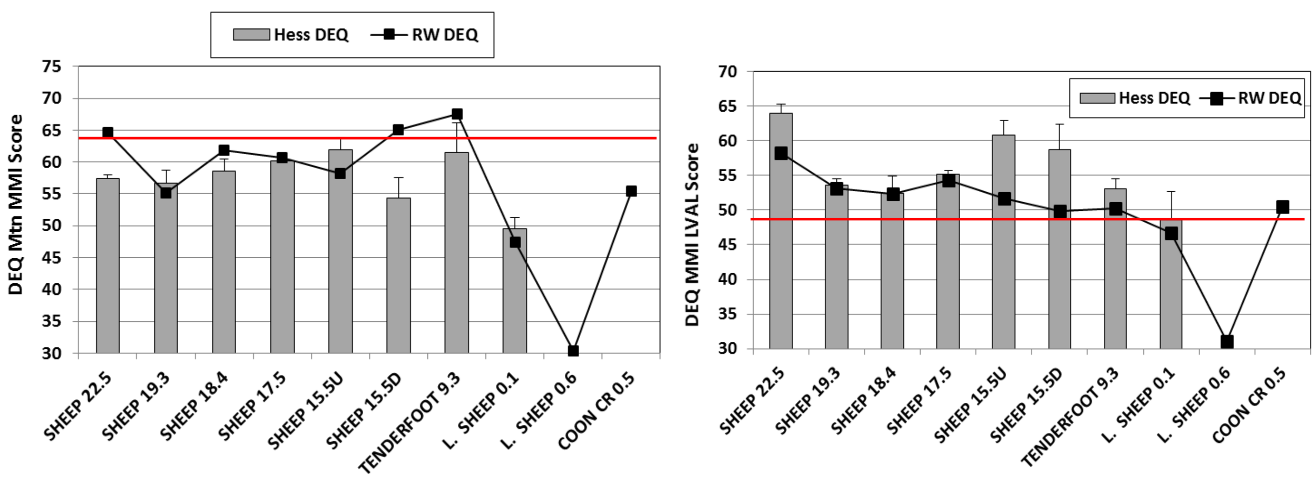


Figure 17. 2018 DEQ Mountain (left) and Low Valley (right) MMI scores calculated for the Reach-Wide (RW) vs. Hess samples (n=3). Red line in the MMI impairment threshold.

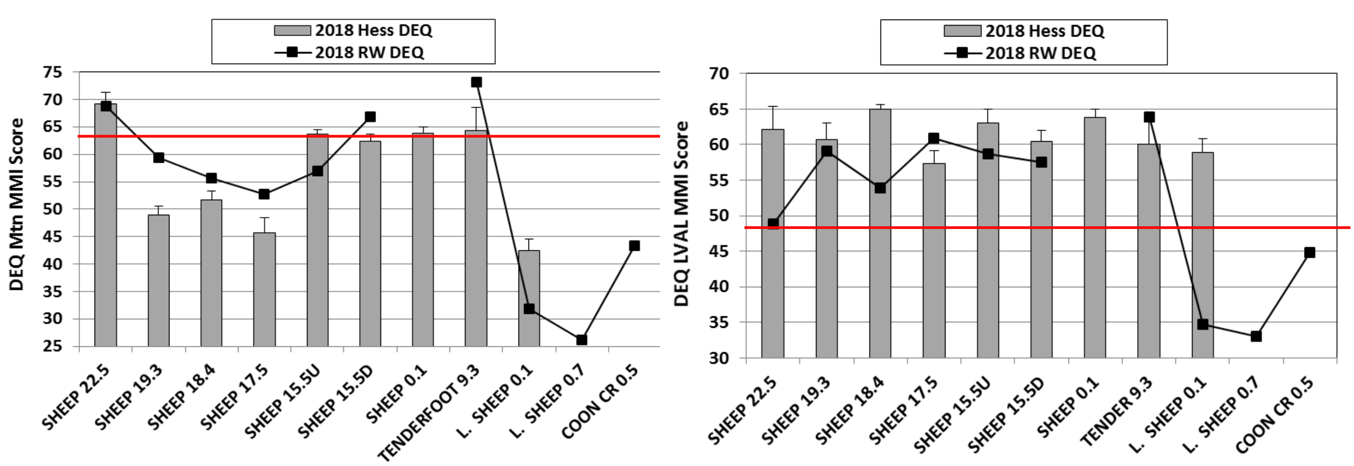
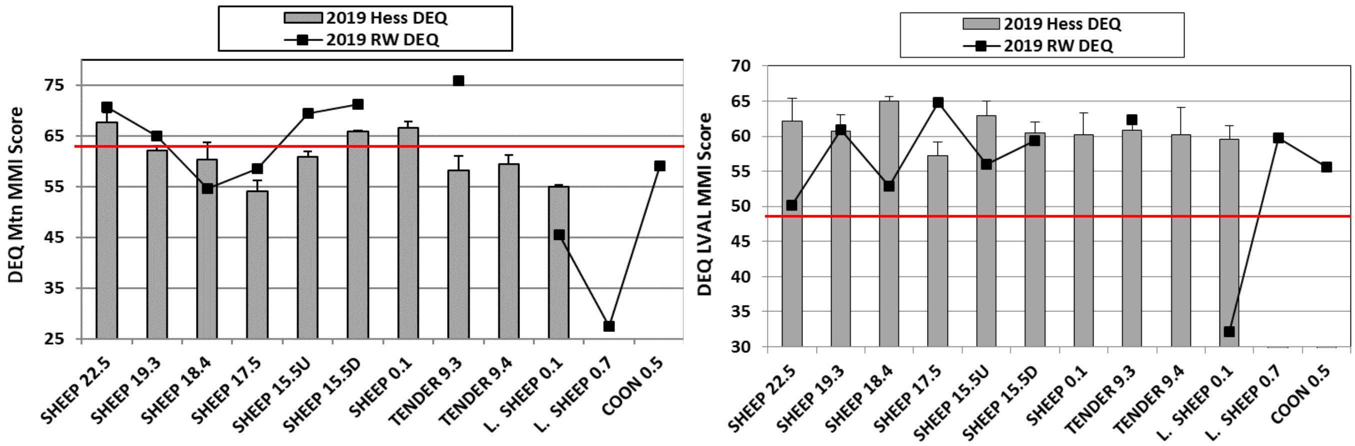


Figure 18. 2019 DEQ Mountain (left) and Low Valley (right) MMI scores calculated for the Reach-Wide (RW) vs. Hess samples (n=3). Red line in the MMI impairment threshold.



Total macroinvertebrate taxa observed at all sites in 2018 were above the non-impaired threshold level of >40 taxa for mountain streams, except Coon Creek CN.5 (**Figure 17**). In 2019, a few sites in Sheep Creek (SH18.4, SH17.5) and Little Sheep (LS.6) have decreased in total taxa richness, likely due to flushing spring flows, while Coon Creek CN.5 has increased (**Figure 17**). In terms of numbers of EPT taxa, all sites except Sheep Creek SH19.2, Little Sheep Creek LS.6 and Coon Creek CN.5 were above the optimal levels of EPT richness (>20 taxa) for mountain streams (**Figure 17**). Little Sheep Creek sites, particularly LS.7/old AQ8, have significantly lower EPT taxa than Sheep Creek or Tenderfoot Creek samples again in 2016 (Table 7); this is one of the few differences noted in 2016, as large improvements in LS.1 macroinvertebrate communities has evened these differences out. A steady increase in the percent of EPT taxa over the past 3 years was noted at sites SH19.2 and CN.5, but %EPT values are still ranked impaired (<50%), as they are in SH18.3 and both Little Sheep Creek sites (LS.1 & LS.6) (**Figure 17**).

Very low percentages (<5%) of the mayfly family Heptageniidae were present in macroinvertebrate communities across the BBC Sheep Creek sites between 2014 and 2019 (**Figure 19**); therefore, no discernable patterns of this mayfly family are evident in the control versus impact sites yet. Tenderfoot Creek TN9.3/TN9.4 and Little Sheep Creek LS.1 reported the highest percentages of Heptageniidae in 2017 and 2018, but significant declines have occurred in LS.1 in 2019 (**Figure 19**). Low percentages of non-insect taxa (<5%) were reported across all Sheep and Tenderfoot Creek sites during all years, while Little Sheep Creek sites have had increasing % of non-insects in the 2017 and 2018 samples, largely due to fingernail clam numbers. Coon Creek's % non-insects had declined since 2014, increased in 2018, then decreased again to <10% in 2019 samples (**Figure 19**).

Figure 19. Macroinvertebrate richness metrics calculated from the RW samples across BBC Sites arranged u/s to d/s. Above the red line indicate optimal mountain stream values (Bukantis 1998).

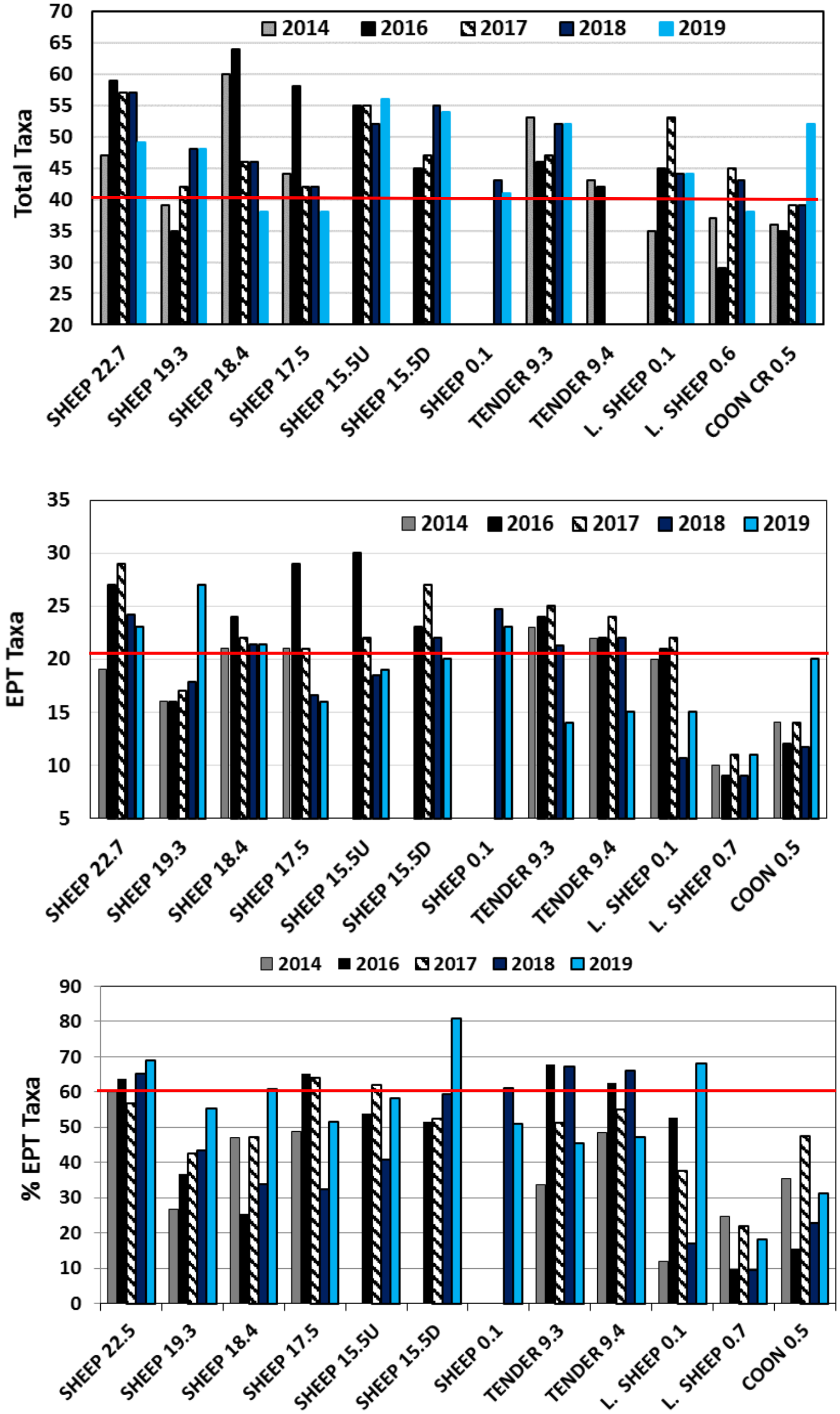
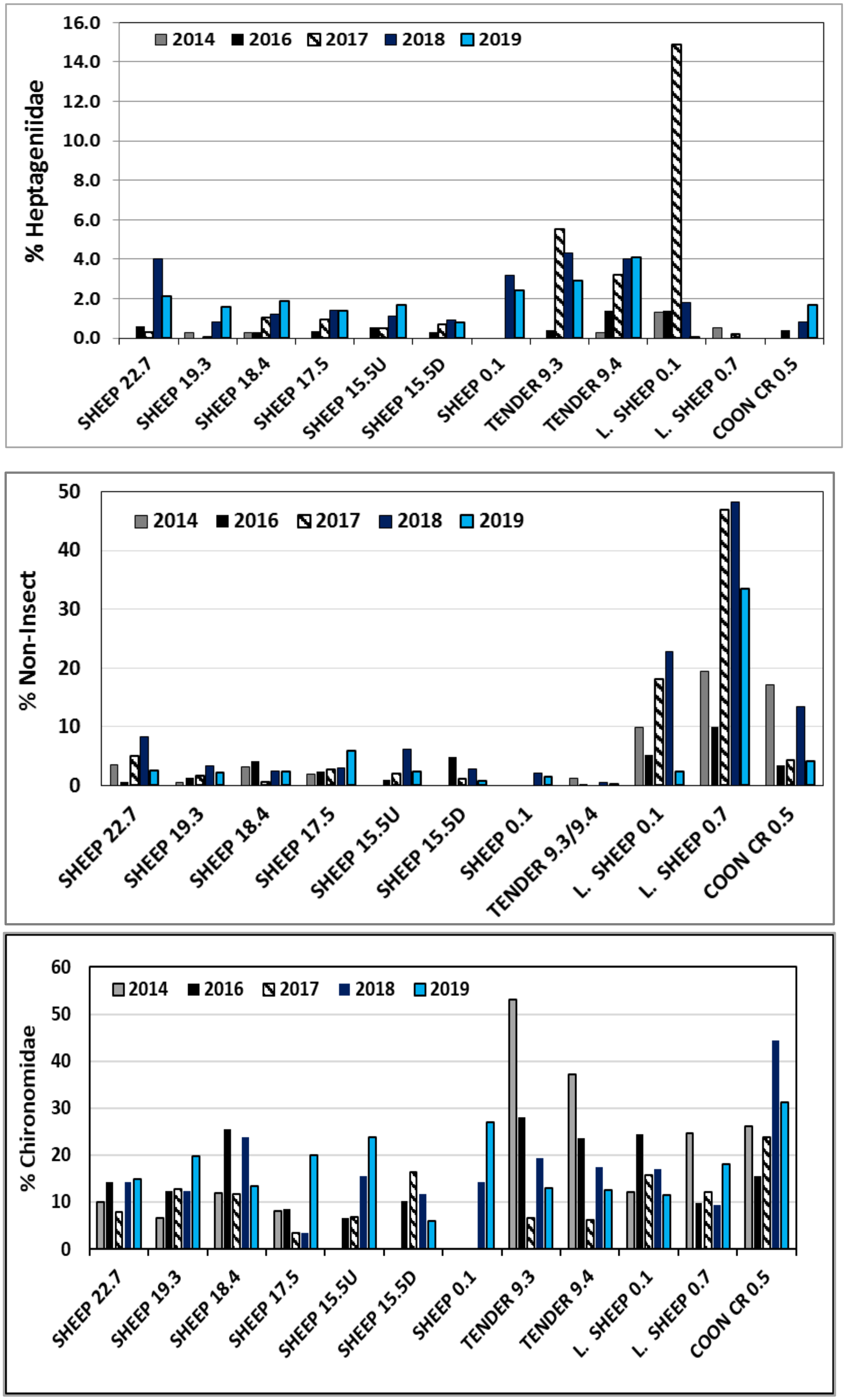


Figure 19. (cont.) Macroinvertebrate metrics, % Non-Insect, % Heptageniidae, and % Chironomidae calculated from the RW samples across BBC Sites arranged upstream to downstream.



HBI scores averaged across all BBC sites were 4.1, 3.4, 3.6, 3.9 and 3.3 for 2014, 2016, 2017, 2018 and 2019 respectively; these scores (>3.0-4.0) qualitatively rank mountain stream communities as slightly impaired for nutrients or organic enrichment (DEQ 2011). Significant improvements (decreases) in HBI scores have been recorded between 2014 and 2016 (T-test, p=0.0004), and 2018 and 2019 (T-test, p=0.015) (**Table 9**). HBI scores at SH22.7 (C), SH 15.5D (I) and TN9.3/9.4 improved to less than 3.0 in 2019 (**Figure 20**). It appears Little Sheep Creek sites (LS.1 & LS.7) were also improving in 2016 (decreased HBI Scores), but scores jumped back up in 2017 (late-summer drought effects) and in 2018 (**Figure 20**). These Little Sheep Creek sites were the only sites in 2018 reporting moderately significant organic pollution with HBI scores of >5.0 (**Figure 20**).

Figure 20. Macroinvertebrate HBI scores, Red to yellow lines bracket the moderate organic impairment range (4.0-5.0), below 4.0 indicates slight impairment.

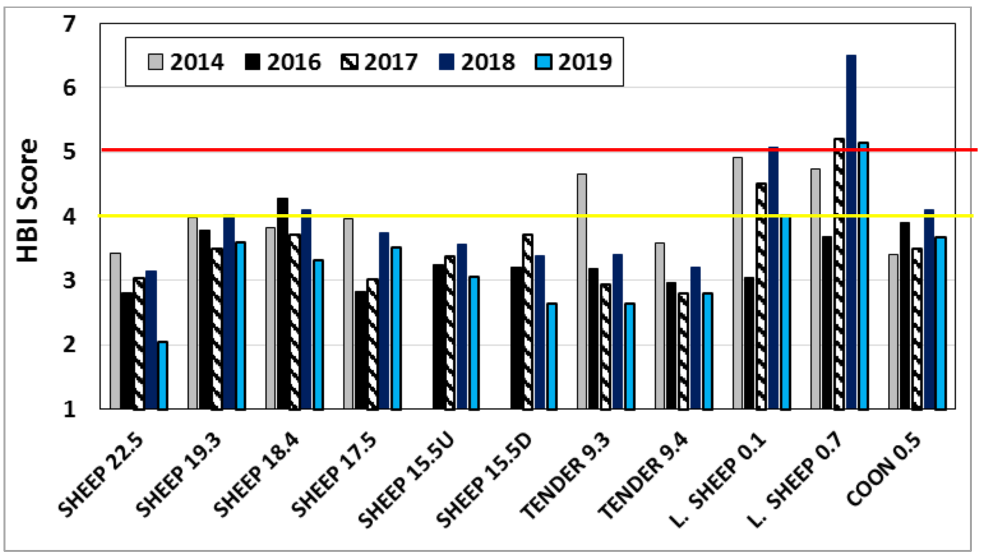


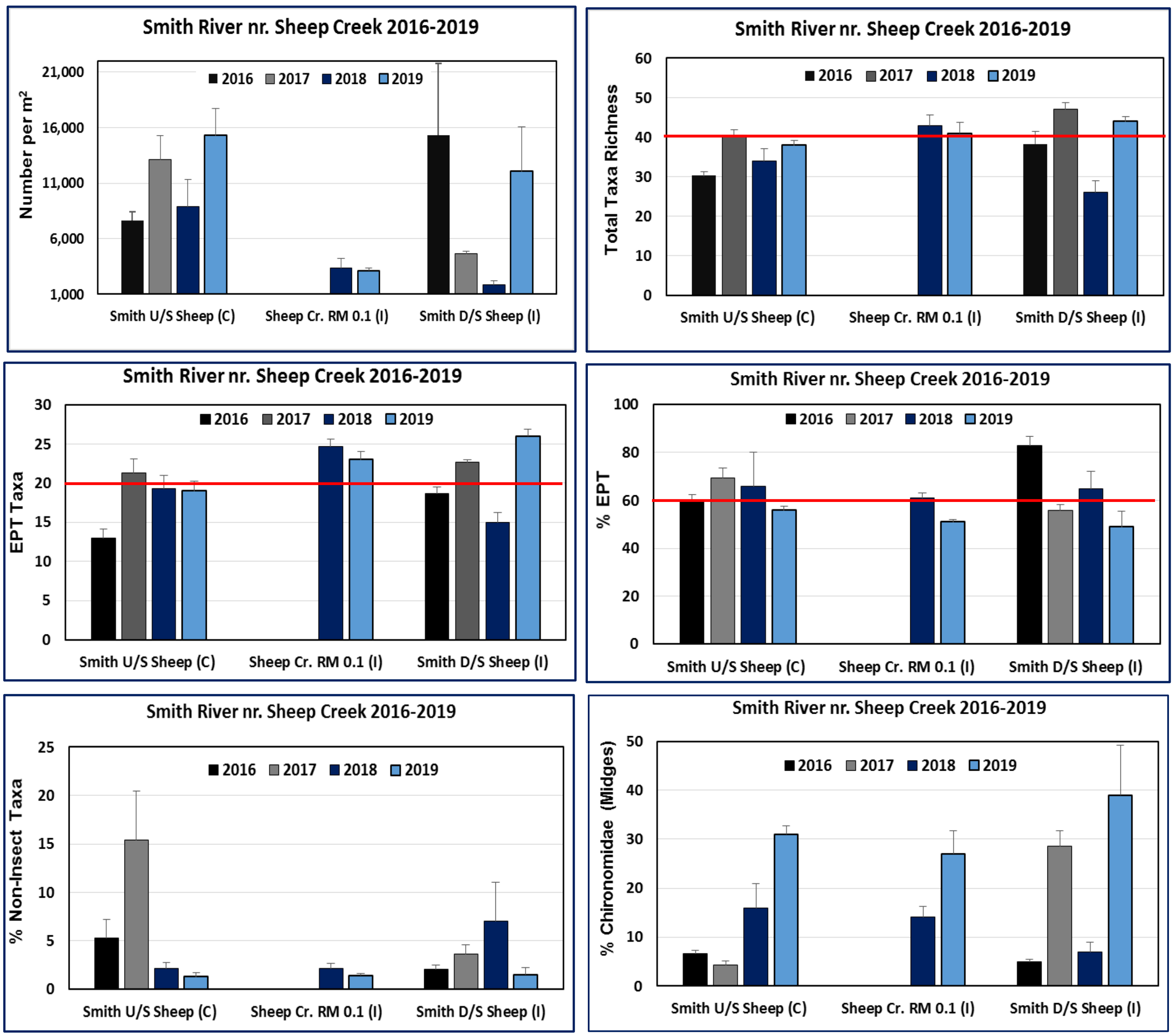
Table 9. Average HBI scores per macroinvertebrate sample from 2014 to 2019. Bolded, shaded HBI scores ≥ 4.0 are considered moderately impaired communities. RM-river mile.

Station ID-RM	Collection Date 8/14-8/15 2014 [1]	7/11-7/14 2016	7/19 + 7/20 2017	7/6-7/9 2018	7/11-7/12 2019
SH22.7 AQ2 (C)	3.4	2.8	3.0	3.2	2.5
SH19.2 AQ3 (C)	3.9	3.8	3.5	4.0	3.5
Control (HBI avg.)	3.7	3.3	3.3	3.6	3.0
SH18.3 AQ4 (I)	3.8	4.3	3.7	4.1	3.1
SH17.5 AQ1 (I)	3.9	2.8	3.0	3.8	3.8
SH15.5U AQ10 (I)		3.2	3.4	3.6	3.1
SH15.5D AQ11 (I)		3.2	3.7	3.4	2.1
SH 0.1 AQ12 (I)				3.6	3.8
Impact (HBI avg.)	3.9	3.4	3.5	3.7	3.2
TN9.3 AQ5 (R')	4.7	3.2	2.9	3.4	2.6
TN9.4 AQ6 (R')	3.6	3.0	2.8	3.2	2.8
Reference (HBI avg.)	4.1	3.1	2.9	3.3	2.7
LS.1 AQ7 (I)	4.9	3.1	4.5	5.1	3.3
LS.6 AQ8 (C)	4.7	3.7	5.2	6.5	5.2
Little Sheep (HBI avg.)	4.8	3.4	4.9	5.8	4.3
CN.5 AQ9* (I)	3.4	3.9	3.5	4.1	4.1
Overall Sites (avg. HBI)	4.1	3.4	3.6	3.9	3.3

3.6.2 Smith River near Sheep Creek Confluence

Four years of Smith River macroinvertebrate data have been collected from upstream and downstream of the Sheep Creek confluence (Stagliano 2018), and the 2018 and 2019 samplings below Sheep Creek (RM 0.1) have revealed some interesting patterns, mostly correlated with higher stream flows of 2018 and 2019. Very abundant benthic macroinvertebrate densities D/S of Sheep Creek in 2016 (~15,000 ind. per m^2) have been significantly reduced in 2017 and 2018, along with reductions in taxa richness, EPT taxa, %EPT, % non-insect taxa and % midges in the samples (**Figure 21**). Some of these declines have caused metrics to drop below optimal levels (2018: Total taxa, EPT taxa), but these rebounded in 2019 (**Figure 21**).

Figure 21. Macroinvertebrate metrics calculated from Hess samples (n=3) from the Smith River upstream (C) and downstream (I) of Sheep Creek (I). Values above red line are optimal (Bukantis 1998).



Other reductions in % non-insect taxa and % Chironomidae at Smith River sites u/s and d/s of Sheep Creek represent improvements in benthic health (**Figure 21**). Increases in multiple macroinvertebrate metrics (EPT taxa, %EPT) were reported in the Smith River u/s of Sheep Creek since the high flows of 2017 and 2018 (**Figure 21**). This site is also exhibiting a steady improvement (lowering tolerance) in the HBI scores; this is the second year this site's community is reporting <4.0 (excellent) tolerance scores and a large increase in the DEQ LVAL MMI Scores (**Figures 22 and 23**).

Figure 22. Average HBI scores for the Smith River area sites. Error bars are SE. Values above threshold lines are indicative of moderate (yellow) to significant (red) organic/sediment enrichment.

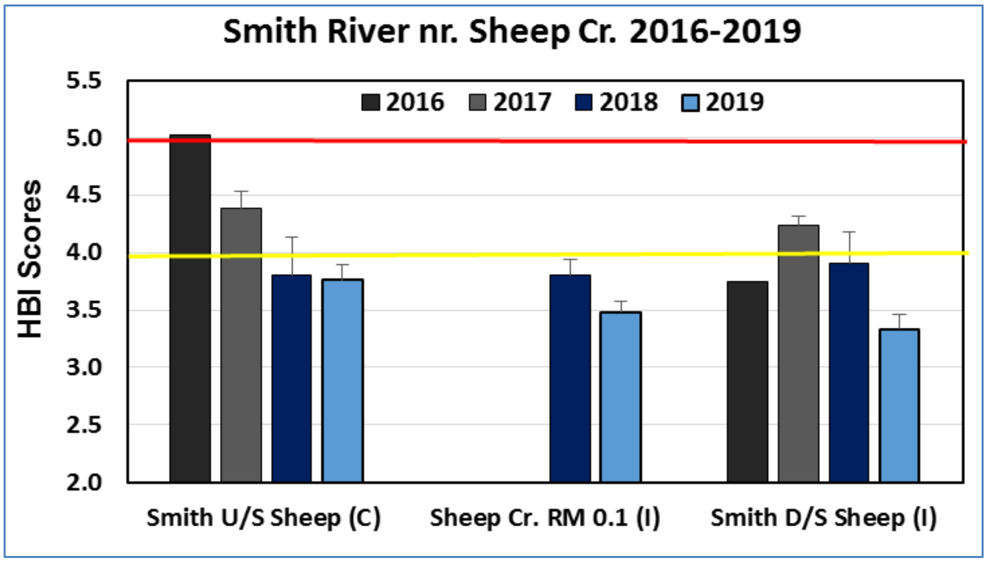
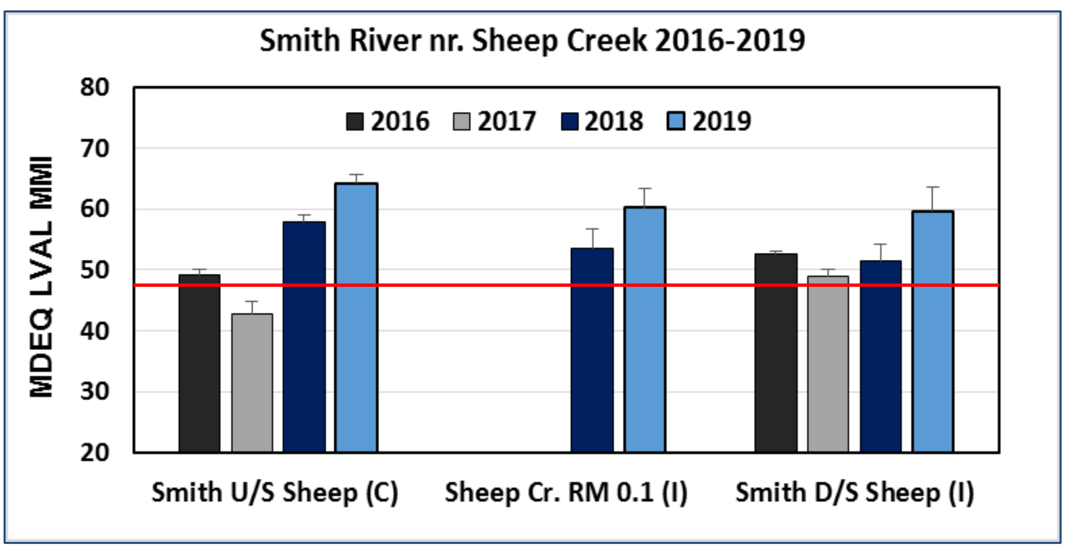


Figure 23. Macroinvertebrate DEQ Low Valley MMI scores for the sites. Error bars are SE. Values above the red line are ranked non-impaired with the MMI threshold (48).



3.7 PERIPHYTON COMMUNITIES

Overall, 167 unique diatom and algae taxa were reported from the 49 periphyton assessment samples collected from 2014 to 2019 (**Appendix E**); 124 diatom and algae taxa were reported in the 2019 samples. Over all years, SH19.2 reported the highest periphyton taxa richness (86 spp.) in 2016, while Little Sheep Creek LS.1 reported the lowest in 2017 (41 spp.) (**Table 10, Figure 22**). The average periphyton richness per site was highest in both 2016 and 2018 at 68.6 and 63.8 taxa, respectively; this is ~11 taxa higher than in 2014. Across all years, Tenderfoot Creek periphyton taxa richness was significantly lower than Sheep Creek sites (T-test, p=0.004), while Sheep Creek control vs. impact periphyton richness are not different (T-test, p=0.35). Tenderfoot Creek had fewer tolerant diatom taxa (avg. 5.2%) and was the least likely to be impaired of all sites (21.9%) in during the five years of the study, 2014 to 2019 (**Table 10, Figures 22 and 23**). Diatoms were the dominant taxa at 10 of 11 study sites in 2018, 6 sites in 2019 and only at 3 sites sampled in 2017 (**Table 11**). The diatom, *Didymosphenia geminata* (a.k.a. rock snot) which can sometimes become invasive, was abundant in the Tenderfoot Creek reaches in 2014 and 2016, but not reported in Sheep Creek. The Cyanobacteria, *Phormidium sp.* was a dominant, non-diatom species at 4 of 10 sites in 2016; especially in the Sheep Creek meadow reaches (SH19.2, SH18.3, LS.1), and at the canyon site (SH17.5) (**Table 11)**. In 2017, *Phormidium* sp. was a dominant taxon in 3 of 9 sites and at only 1 site in 2018 (**Table 11**). This toxic, algae-like taxon can form thick, brown-black slimy mats on rocks and displace important mayfly, stonefly and caddisfly taxa (**Photo 4**); it was not the 1st or 2nd dominant taxa at any site in 2014 (**Table 11**). Abundant filamentous algae outbreaks observed at the lower Sheep Creek sites (SH15.5U and SH15.5D) in 2016 was confirmed with *Cladophora* sp. being the dominant taxa in the periphyton samples at both sites (**Table 11**). This nuisance algae outbreak was not observed in 2017.

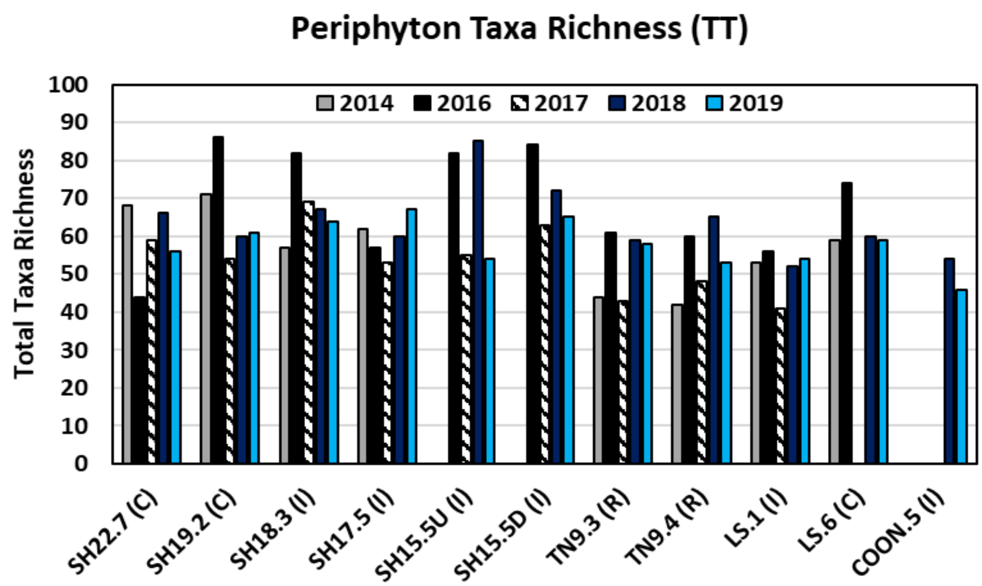
Table 10. Periphyton sample metrics: total taxa in the sample, % relative abundance of tolerant taxa (% RA). Probable Impairment (%PI) values are underlined. Control (C), Impact (I) and Reference (R).

		2016			2017			2018			2019		
Site ID	Station ID	Total Taxa	% RA	% PI	Total Taxa	% RA	% PI	Total Taxa	% RA	% PI	Total Taxa	% RA	% PI
AQ2	SH22.7 (C)	44	8.4	28.8%	59	5.6	22.3%	66	22.1	70.2%	56	5.1	21.1%
AQ3	SH19.2 (C)	86	19.6	62.1%	54	6.5	24.2%	60	11.3	36.9%	61	17.9	57.0%
AQ4	SH18.3 (I)	82	27.5	82.2%	69	16.7	52.9%	67	19.3	61.4%	64	14.6	46.9%
AQ1	SH17.5 (I)	57	12.8	41.4%	53	7.9	27.6%	60	17.7	56.6%	67	12.6	41.2%
AQ10	SH15.5U (I)	82	12.7	41.3%	55	2.4	15.4%	85	11.8	38.2%	54	20.5	65.5%
AQ11	SH15.5D (I)	84	12.1	40.0%	63	5.7	22.4%	72	16.6	52.7%	65	15.1	48.1%
AQ5	TN9.3 (R)	61	3.4	17.7%	43	2.7	16.2%	59	8.7	30.0%	58	7.1	25.8%
AQ6	TN9.4 (R)	60	4.3	19.8%	48	3.5	18.0%	65	11.1	36.6%	53	5.6	22.3%
AQ7	LS.1 (I)	56	11.7	37.9%	41	5.4	21.8%	52	11.9	38.3%	54	12.1	40.0%
AQ8	LS.7 (C)	74	5.9	22.9%	--	--	--	60	13.1	42.3%	59	8.9	30.4%
AQ9	CN.5 (I)	--	--	--	--	--	--	54	27.9	82.8%	46	23.4	72.4%

Table 11. Periphyton sample metrics for BBC sites: 1st and 2nd dominant taxa groups are listed. Control (C), Impact (I) and Reference (R).

		2016		2017		2018		2019	
Site ID	**Station ID**	**Dominant Taxa 1**	**Dominant Taxa 2**	**Dominant Taxa 1**	**Dominant Taxa 2**	**Dominant Taxa 1**	**Dominant Taxa 2**	**Dominant Taxa 1**	**Dominant Taxa 2**
AQ2	SH22.7 (C)	*Tolypothrix*	Diatoms	*Calothrix*	Diatoms	Diatoms	*Stigeoclonium*	*Cladophora*	Diatoms
AQ3	SH19.2 (C)	Diatoms	*Phormidium*	*Phormidium*	Diatoms	*Cladophora*	Diatoms	*Cladophora*	Diatoms
AQ4	SH18.3 (I)	Diatoms	*Phormidium*	*Phormidium*	Diatoms	Diatoms	*Phormidium*	Diatoms	*Leptolyngbya*
AQ1	SH17.5 (I)	Diatoms	*Phormidium*	*Closteridium*	Diatoms	Diatoms	*Cladophora*	Diatoms	*Calothrix*
AQ10	SH15.5U (I)	*Cladophora*	Diatoms	Diatoms	*Nostoc*	Diatoms	*Cladophora*	*Cladophora*	Diatoms
AQ11	SH15.5D (I)	*Cladophora*	Diatoms	Diatoms	*Nostoc*	Diatoms	*Cladophora*	Diatoms	*Homoeothrix*
AQ5	TN9.3 (R)	Diatoms	*Nostoc*	Diatoms	*Nostoc*	Diatoms	*Nostoc*	Diatoms	*Leptolyngbya*
AQ6	TN9.4 (R)	Diatoms	*Nostoc*	*Nostoc*	Diatoms	Diatoms	*Nostoc*	Diatoms	*Homoeothrix*
AQ7	LS.1 (I)	Diatoms	*Phormidium*	*Phormidium*	Diatoms	Diatoms	*Homoeothrix*	*Cladophora*	Diatoms
AQ8	LS.7 (C)	Diatoms	*Cladophora*	--	--	Diatoms	*Cladophora*	*Cladophora*	Diatoms
AQ9	CN.5 (I)	Diatoms	*Cladophora*	--	--	Diatoms	*Pseudanabaena*	Diatoms	*Leptolyngbya*

Figure 24. Total taxa richness calculated from the DEQ Peri-MOD samples arranged upstream (L) to downstream (R). Control (C), Impact (I) and Reference (R).



Based on Teply's interpretation of the Trophic Diatom Index, in 2016, two Sheep Creek sites, SH18.3(I) and SH19.2(C) had the highest probability of impairment at 82% and 62%, respectively (**Figure 24**). These high percentages of tolerant taxa decreased in 2017 to a less impaired status. All sites sampled in 2017 were significantly less likely to be impaired than in 2016; although, SH18.3/AQ4 was still over the impairment threshold (**Figure 23**). A steady decrease in % probable impairment was seen at other Sheep Creek sites, SH22.7, SH17.5, between 2014 and 2017, but this trend reversed in 2018 to report the highest number of sites (5 of 11) above the TDI probable impairment threshold (significantly higher than 2017 across all sites avg. p=0.0012). Increases in the probable impairment of the diatom community in 2018 included the Tenderfoot reference reaches (**Figure 25**). Other Sheep Creek and Little Sheep Creek sites had less than a 28% chance of being impaired in 2017 based on the TDI (**Figure 23, Table 9**). Both Tenderfoot Creek reference sites were least likely to be impaired (<20%) in 2014, 2016 and 2017, but these jumped up to >30% in 2018 (**Figure 25**). And with *Nostoc* representing the 2nd dominant taxa across most years (**Table 10**), there is likely some nutrient loading from livestock use in the Tenderfoot watershed. In 2019, only one Sheep Creek control (SH19.3) and one impact site (SH15.5U) had >50% probability of being impaired; Coon Creek was above this threshold on both years of sampling (2018 and 2019) (**Figure 25**).

Figure 25. Trophic diatom index (TDI) calculated from the Peri-MOD samples arranged u/s to d/s. Control (C), Impact (I) and Reference (R). Above the red line indicates impairment.

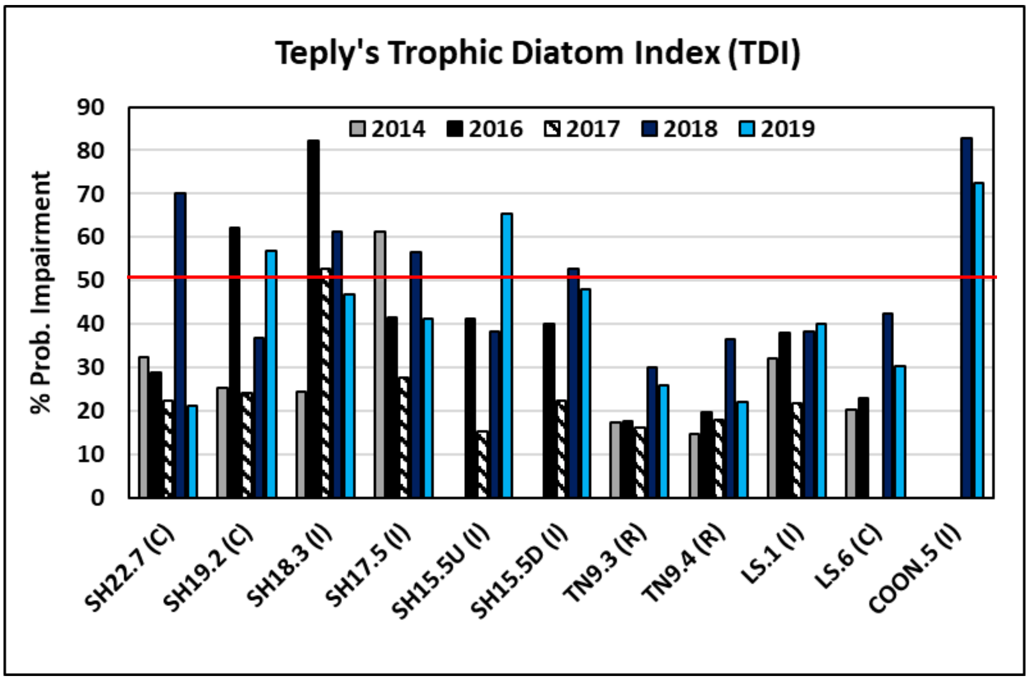


Photo 4. Cyanobacteria, *Phormidium sp.* covering a rock (Creative Commons© photo) (left) and the nuisance diatom, *Didymosphenia geminata* in Tenderfoot Creek TN9.3 in 2016 (right).

3.8 Chlorophyll-*a*

No chlorophyll-*a* samples were collected by Tintina in 2017 because benthic algal levels at all transects of the Sheep Creek reaches were observed to be low (<50 mg/m^2, ⅓ the nuisance level of 150 mg/m^2) and underwater photographs of the substrate at each transect were taken instead (available for record) (**Appendix A, Photo 20**). Abundant filamentous algae outbreaks were observed at the lower Sheep Creek sites (SH15.5U and SH15.5D) in 2016, and these were likely above the nuisance levels, and *Cladophora* was the dominant taxa, but Chl-*a* samples were not taken (**see 3.7 Periphyton section**). Chl-*a* levels sampled by DEQ in 2015 from Sheep and Moose Creek sites were well below the nuisance levels of 150 mg/m^2, and the threshold levels of 120 mg/m^2 (DEQ 2017) (**Table 12**).

Table 12. Chlorophyll-a levels reported from 2015 using the weighted average for 11 transect templates (DEQ 2017). Sheep Creek Control (C), Impact (I) and Reference (R) sites.

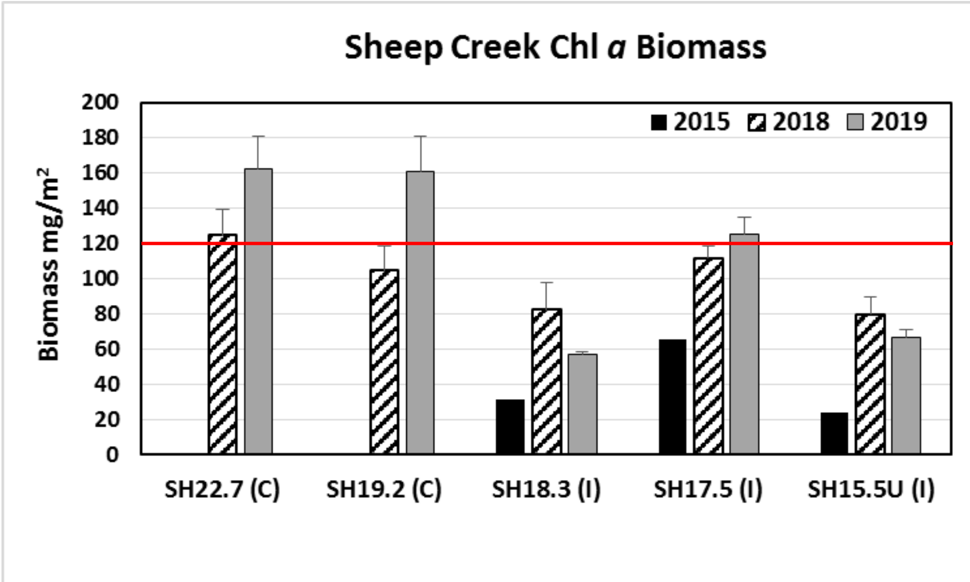
Site ID	Coll. Date	Chl A densities (mg/m2)
SH15.5U/AQ10 (I)	8/19/2015	23.5 mg/m2
SH17.5 /AQ1 (I)	8/19/2015	65.2 mg/m2
SH18.3 / AQ4 (I)	8/19/2015	31.4 mg/m2
MOOSE 0.5 (R)	8/19/2015	53.7 mg/m2

Chl-*a* levels sampled on August 13, 2019 from both Sheep Creek control sites (C) upstream of the BBC project are above the threshold level (120 mg/m^2), as well as above nuisance levels of 150 mg/m^2 (**Table 13, Figure 26**); Chl-*a* samples taken downstream of BBC project area, SH17.5 (I), also had transects exhibiting levels above the threshold (**Table 13**), but overall in 2019, Control Sites (n=2) had significantly higher Chl-*a* biomass levels than the Impact Sites (n=3) (T-test, p=0.00001). We sampled these sites in mid-August, and the large biomass of filamentous algae was already beginning to senesce and decay (brown coloration) (**Appendix A, Photo 5**). In 2018, only the control site SH22.7 reported CHl-*a* levels above the 120 mg/m^2 threshold, but the control sites still had significantly higher Chl-*a* levels than the impact sites (T-test, p=0.05) (**Figure 26**).

Table 13. Chlorophyll-*a* levels reported from August 2019 using the weighted average for 5 transect composites. Sheep Creek Control (C) and Impact (I) sites. Shaded values are above threshold levels.

	8/13/2019	CHL A biomass mg/m2					
Site ID	Station ID	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Avg.
AQ2	SH22.7 (C)	132.5	176.5	115.0	151.9	235.7	162.3
AQ3	SH19.2 (C)	226.4	198.5	150.5	108.3	121.1	161.0
AQ4	SH18.3 (I)	56.2	50.8	61.4	60.2	54.1	56.5
AQ1	SH17.5 (I)	161.0	113.0	93.9	127.1	129.5	124.9
AQ10	SH15.5U (I)	57.9	62.1	57.6	82.4	73.3	66.7

Figure 26. Chlorophyll-*a* levels reported for Sheep Creek Control (C) and Impact (I) sites from 2015, 2018 and 2019 using the weighted average for 5 transect composites. Error bars are ± SE. Red line is the threshold level for nutrient impairment.



3.9 AMPHIBIAN AND REPTILE OBSERVATIONS

Two amphibian species, the Columbia spotted frog (*Rana luteiventris*) and the western toad (*Anaxyrus boreas*), a Montana SOC, were incidentally recorded during the 2016 summer surveys at Sheep Creek sites SH18.3 and SH22.7, respectively. The western toad had been previously recorded within 1.6 km of Sheep Creek site SH22.7 (MNHP 2016) but had not been observed during our 2014 or 2015 surveys until summer of 2016, and was not observed again in 2017, 2018 or 2019 (Stagliano 2019). The Columbia spotted frog was observed at additional sites in 2017 and 2018 (Sheep Creek sites SH15.5D, SH22.7 & SH19.2, Little Sheep Creek LS.1, lower Coon Creek and Moose Creek MO.1). Two terrestrial garter snakes (*Thamnophis elegans*) were observed during summer surveys in 2016, 2017 and 2019 along the Tenderfoot Creek TN9.3 reach. We also observed a terrestrial garter snake eating a rainbow trout at the Moose Creek (MO.1) reach in the fall of 2017. These were the only herpetofauna occurrences reported in conjunction with the seasonal aquatic survey visits.

4.0 CONCLUSIONS

Over the 6 years of fish surveys, salmonid population estimates have varied significantly spatially, temporally, and between years. In fact, so much variability and species abundance fluctuations have occurred at both the control site SH19.2 (C) and impact sites, SH18.3, SH17.5, SH15.5U, that the ability to detect pre- and post-impacts may be very challenging, until a steady baseline is reached. Between 2014 and 2019, overall salmonid densities and larger size-classes have been steadily declining in the immediate BBC project area (SH19.2, SH18.3, SH17.5, LS.1), as well as in Tenderfoot Creek reference reaches. In contrast, the lower Sheep Creek Sites (SH15.5U/SH15.5D) have been exhibiting increases in estimated salmonid numbers over the last couple years, especially RBT in the 100-200 mm size-class which have been out-migrating from Moose Creek in large numbers. LOLE still maintain their highest densities and biomass in the meadow reaches of Sheep Creek SH19.2 and SH18.3, but MOWF have become more dominant. In the summer of 2017, low flow stream conditions became so unfavorable that EBT migrated out of the Little Sheep Creek LS.7 /AQ8 and Brushy Creek, not to return until the spring of 2018. These environmental conditions in Little Sheep Creek, in addition to large beaver dams in the Sheep Creek meadow reaches, may be reasons for decreased EBT and LOLE redds counted between 2016 and 2019.

Despite reports of WCT presence in the Sheep Creek study area (MFWP 2014, MNHP 2015), only CT x RBT hybrids (overall phenotypic traits appear much less than 90% pure) were collected (<1% of salmonid population) during 6 years of seasonal site surveys. Therefore, it is my professional opinion that aquatic SOC are historical occurrences, and not currently extant in the BBC project area. In the fall of 2017, we collected one individual pure WCT at the Tenderfoot Site; another surprise species collected for the first time during the study in 2017 was a single Mountain Sucker at the lowest Sheep impact site (SH15.5D).

Fisheries population conclusions between 2014 and 2019 can be summed up as follows:

1) Compared to historical data (1970 and 1992) evaluated at two Sheep Creek locations near the project area, current RBT populations are sub-optimal, LOLE are now present and common (they were absent from prior surveys), and sites are now absent of pure, native WCT (reported in low numbers in the 1970 study).

2) RBT adults were sparse to virtually absent from the BBC project area during spring sampling events between 2015 and 2017, no redds have been observed 2015-2019, and no pit-tagged RBT from the MSU/FWP study were reported upstream of Sheep Creek impact site SH17.5 at any time between 2016 and 2019. A large beaver dam located between SH19.2 and SH18.3 may be influencing movement and recolonization of RBT due to their declining trends at SH19.2. For the first time since 2014, RBT were not collected at the Sheep SH19.2 control site in 2019.

3) LOLE adults in the immediate Sheep Creek project area have used lower Little Sheep Creek as a thermal refuge in the winter, and are largely resident in the meadow reaches based on the recapture rate of previously marked individuals, and no newly detected pit-tagged individuals during any season.

4) Fall redd counts indicated that the highest number of LOLE redds (avg. 3.1 per 100 m or ~50 per mile in 2016) are located within the Sheep Creek BBC meadow reaches SH19.2 and SH18.3, but substantially decreased redd counts (½ to ⅓ of 2016 counts) were reported in 2017, 2018 and 2019. This may be due to lower fall stream discharge in 2017 and 2018 compared to 2016. EBT redds are concentrated in lower Little Sheep Creek (LS.1) (⅓ the numbers of 2016) and Moose Creek (MO.1). No RBT redds were observed in any Sheep or Little Sheep Creek reaches in spring of 2018 or 2019, but low numbers (1 or 2) were reported in lower Moose.

5) MOWF are moving into the BBC project reach from downstream in Sheep Creek, especially in the summer, as indicated by 4 pit-tagged individuals being captured at SH19.2 and SH18.3 in 2016. Other pit-tagged salmonids detected in Sheep Creek in 2016 are largely being recaptured at their original tagging sites, SH17.5 and SH15.5U. No pit-tagged salmonids were captured at any site between 2017 and 2019.

6) Moose Creek is a salmonid production area with the highest densities of salmonids reported from any site (~1,000 and ~2,400 per mile) in fall surveys of 2017 and 2018, respectively; only EBT in LS.1 approached these densities: avg. ~900 per mile. The high frequency of small size-classes (<150 mm) including juveniles (~50-75 mm) of EBT and RBT in Moose Creek indicate that many were likely spawned and reared in this Creek. These RBT are out-migrating and augmenting populations at the downstream sites SH15.5U and SH15.5D.

Benthic Community Summary Conclusions between 2014 and 2019:

1) During 5 years of benthic sampling, we have documented that the current stream macroinvertebrate and periphyton communities are slightly to moderately impaired at most sites in Sheep and Little Sheep Creeks, likely from sediment and/or nutrient enrichment. This was less prevalent in the Tenderfoot Creek reference sites TN9.3/9.4. Improvements in macroinvertebrate HBI and MMI scores from the 2019 sampling results reflect the effects that flushing flows can have on the benthic communities, by reducing densities and taxa richness, while increasing biointegrity by removing silt-tolerant taxa (decreasing HBI scores) and improving biological health.

2) Across all sites in 2019, the macroinvertebrate communities reported the 2nd highest biological integrity scores (avg. DEQ Mtn. MMI=60.4) since the highest scoring DEQ MMI average of 60.7 in 2016, and Sheep Creek MMI scores are slightly higher, and not significantly different from the Tenderfoot Creek Scores. HBI Scores were significantly lower (avg. 3.5) in 2019 than in 2018 (avg. 3.9). Periphyton communities in 2019 had 3 sites with >50% probability of impairment, whereas in 2018, 5 sites had >50% chance of being impaired. Despite these improvements, Chl-*a* levels at 3 of the 5 Sheep Creek sites in 2019 still indicate nutrient impairments.

3) Riparian habitat at 6 sites (SH22.7, TN9.3, LS.1, MO.1, AQ8 and SH15.5U) ranked degraded because of livestock use, while Sheep Creek sites SH17.5 and SH22.7 are functional, but at risk

because of adjacent road effects on the hydrology. Surprisingly, baseline biotic integrity of macroinvertebrate and periphyton communities were significantly higher in the Tenderfoot Creek TN9.3 and the Sheep Creek SH22.7 control reaches despite these riparian alterations.

4) Even study sites with high-quality riparian and in-stream habitat conditions are exhibiting slight to moderate impairment of their biological communities. This is corroborated by HBI and TDI scores being elevated across most sites indicating probable nutrient or other organic enrichment. The common result of riparian livestock use is increased fine benthic sediments and the macroinvertebrate and periphyton communities might be exhibiting the deleterious effects of this ubiquitous stressor. Abundant *E. coli* bacteria detected throughout Sheep Creek (DEQ 2017) may be the cause of the OR disease documented in increasing numbers (>10%) of EBT in Little Sheep Creek and downstream of Moose Creek.

5) Diverse aquatic communities with high biological integrity are usually correlated with intact riparian conditions and diverse habitat quality (Allan et al. 1997), but the streams of this study have a mixed relationship; Tenderfoot Creek TN9.4 and Sheep Creek SH18.3 both report high aquatic diversity and habitat quality, while Tenderfoot TN9.3 and Sheep Creek SH22.7 have high biotic integrity, but lower riparian habitat quality.

6) During all years except 2019, Sheep Creek impact sites (SH18.3, SH17.5, SH15.5U/D) have exhibited significantly lower biological integrity, as measured by the macroinvertebrate MMIs, than the Tenderfoot Creek reference sites; however, this is not the case with the Sheep Creek control sites (SH22.7, SH19.2) versus the Tenderfoot Creek reference.

7) Low numbers of the mayfly family, Heptageniidae across most study reaches was somewhat surprising, since the absence or decreased abundance of this group has been shown to be a measure of a community's sensitivity to heavy metal impacts. Further investigations to prior mining activities in the watershed might be needed to explain this observation; although, even the reference reaches on Tenderfoot Creek have reported low numbers.

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Appendix A
Site Photographs

Photo 1. Moose Creek MO.1 Site July 2019 Fish Sampling.

Photo 2. Sheep Creek SH18.3/AQ4 Fish Work-up Station.

Photo 3. Sheep Creek SH22.7/AQ2, lower reach.

Photo 4. Sheep Creek SH17.5/AQ1,fish sampling 2018.

Photo 5. Sheep SH19.2/AQ3, abundant algae in August 2019

Photo 6. Sheep Creek SH15.5U/AQ10, Tote Barge in the Rain.

Photo 7. Tenderfoot Creek TN9.3 pure westslope cutthroat 2018.

Photo 8. Sheep 22.7 Fall 2018 Brown Redd.

Photo 9. Little Sheep LS.1/ AQ7 large brown that likely overwintered in the creek, July 2019.

Photo 10. Sheep Creek SH15.5U/AQ10, August Chl-a sampling

Photo 11. Little Sheep LS.7, setting block seine 2019.

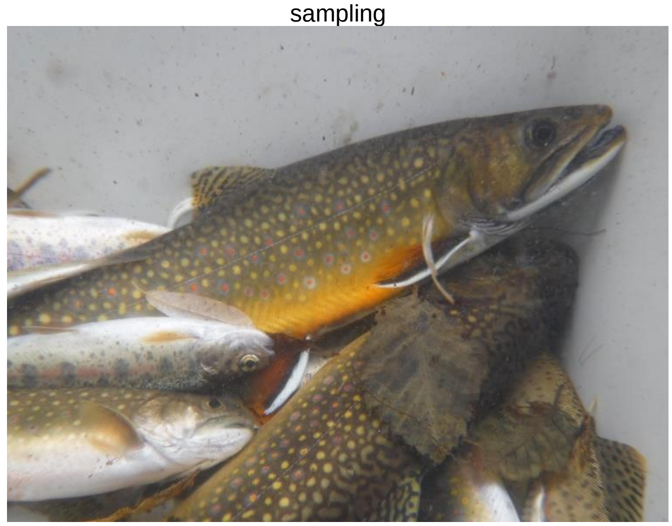


Photo 12. Moose Creek Fall 2018 EBT and RBT

Appendix B

Seasonal Fish Average Abundance

Appendix B. Seasonal fish species population estimates (Number per mile) by site.

SH22.7 / AQ2 (Control)	Fall 2014	Summer 2015	Spring 2016	Summer 2016	Fall 2016	Spring 2017	Summer 2017	Fall 2017	Summer 2018	Summer 2019	Avg.	SE
Brook Trout	**92**	**13**	13	26	35	16	32	78	48	4	**35.8**	**9.2**
Rainbow Trout	**13**	**59**	0	141	36	16	195	52	96	42	**65.0**	**19.6**
RBTxCT Hybrid	**0**	**0**	0	0	0	0	0	0	0	16	**1.6**	**1.6**
Brown Trout	**13**	**26**	13	13	44	8	8	52	8	47	**23.3**	**5.6**
Mountain Whitefish	**26**	**26**	0	0	0	16	16	10	0	5	**9.9**	**3.4**
Rocky Mtn. Sculpin	**2745**	**2376**	475	1156	1162	231	1138	1186	1108	676	**1225.3**	**247.6**
Total Salmonids	**145**	**125**	**26**	**180**	**115**	**55**	**250**	**192**	**152**	**114**	**135.6**	**20.6**

SH19.2 / AQ3 (Control)	Fall 2014	Summer 2015	Spring 2016	Summer 2016	Fall 2016	Spring 2017	Summer 2017	Fall 2017	Summer 2018	Summer 2019	Avg.	SE
Brook Trout	26	13	13	89	18	0	26	78	26	6	29.6	9.4
Rainbow Trout	209	156	40	89	114	26	42	63	64	0	80.3	20.1
RBTxCT Hybrid	0	35	0	0	0	0	0	0	0	5	4.0	3.5
Brown Trout	79	26	79	70	142	99	63	161	120	18	85.8	14.6
Mountain Whitefish	40	13	79	151	80	52	31	52	50	25	57.3	12.4
Rocky Mountain Sculpin	1874	1487	475	1382	926	224	772	837	468	707	915.2	163.5
Longnose Dace	26	13	0	9	26	0	36	26	10	21	16.8	3.9
White Sucker	26	0	0	18	79	0	5	5	18	7	15.9	7.6
Total Salmonids	**354**	**244**	**211**	**399**	**354**	**177**	**163**	**354**	**260**	**54**	**257**	**34.5**

Appendix B. Seasonal fish species population estimates (Number per mile) by site

SH18.3 / AQ4 (Impact)	Fall 2014	Summer 2015	Spring 2016	Summer 2016	Fall 2016	Spring 2017	Summer 2017	Fall 2017	Summer 2018	Summer 2019	Avg.	SE
Brook Trout	0	0	13	0	0	0	0	0	16	6	4	2.0
Rainbow Trout	92	91	66	124	106	52	109	166	36	28	87	13.4
RBTxCT Hybrid	0	0	0	0	0	0	0	0	0	6	1	0.6
Brown Trout	143	91	106	71	132	10	68	114	84	47	87	12.6
Mountain Whitefish	124	143	40	195	158	78	36	16	72	136	100	18.9
Rocky Mtn. Sculpin	835	1235	422	1598	2605	100	733	1064	806	733	1013	219.6
White Sucker	0	0	0	18	79	5	5	0	0	6	11	7.7
Longnose Dace	0	0	0	0	18	5	16	26	0	0	6	3.1
Total Salmonids	**359**	**325**	**224**	**390**	**396**	**140**	**213**	**296**	**208**	**223**	**277.5**	**27.79**

SH17.5 / AQ1 (Impact)	Fall 2014	Summer 2015	Spring 2016	Summer 2016	Fall 2016	Spring 2017	Summer 2017	Fall 2017	Summer 2018	Summer 2019	Avg.	SE
Brook Trout	0	0	0	0	26	0	0	0	12	4	**4.2**	**2.7**
Rainbow Trout	422	277	35	194	370	61	125	304	224	94	**210.6**	**41.9**
RBTxCT Hybrid	79	0	13	26	0	0	0	20	12	35	**18.5**	**7.8**
Brown Trout	119	0	53	18	53	10	63	78	63	14	**47.0**	**11.6**
Mountain Whitefish	0	158	44	0	18	16	5	42	12	87	**38.2**	**15.8**
Rocky Mtn. Sculpin	4508	3265	924	1263	2087	1518	1699	1310	1700	613	**1888.7**	**369.5**
Total Salmonids	**620**	**436**	**145**	**238**	**440**	**87**	**193**	**444**	**323**	**234**	**314.3**	**52.5**

Appendix B. Seasonal fish species population estimates (Number per mile) by site. ***NS=not surveyed***

SH15.5U / AQ10 (impact)	Spring 2016	Summer 2016	Fall 2016	Summer 2017	Fall 2017	Summer 2018	Summer 2019	Avg.	SE
Brook Trout	13	62	18	21	5	48	32	**28.3**	**7.6**
Rainbow Trout	18	62	224	36	39	560	296	**176.3**	**75.7**
RBTxCT Hybrid	0	0	0	0	0	0	5	**0.7**	**0.7**
Brown Trout	0	26	26	21	24	39	46	**26.1**	**5.5**
Mountain Whitefish	26	88	97	47	43	190	178	**95.6**	**24.7**
White Sucker	0	0	0	0	5	11	4	**2.9**	**1.6**
Longnose Dace	0	0	0	0	0	5	25	**4.3**	**3.5**
Rocky Mtn. Sculpin	66	766	2832	1565	1279	1622	892	**1288.9**	**327.2**
Total Salmonids	**57**	**238**	**365**	**125**	**111**	**837**	**557**	**327.1**	**107.2**

SH15.5D / AQ11 (Impact)	Spring 2016	Summer 2016	Fall 2016	Summer 2017	Fall 2017	Summer 2018	Summer 2019	Avg.	SE
Brook Trout	0	18	0	10	20	NS	14	**10.4**	**3.6**
Rainbow Trout	53	98	79	104	371	NS	192	**149.5**	**48.3**
RBTx CT Hybrid	0	0	0	0	0	NS	7	**1.2**	**1.2**
Brown Trout	0	0	26	26	16	NS	35	**17.2**	**6.0**
Mountain Whitefish	13	89	70	26	82	NS	122	**67.1**	**16.7**
White Sucker	0	0	0	0	0	NS	0	**0.0**	**0.0**
Mountain Sucker	0	0	0	0	4	NS	0	**0.7**	**0.6**
Longnose Dace	0	0	0	0	59	NS	7	**11.0**	**9.0**
Rocky Mtn. Sculpin	660	554	757	921	1451	NS	401	**790.6**	**150.4**
Total Salmonids	**66**	**205**	**176**	**166**	**489**	**NS**	**370**	**245.4**	**71.1**

Appendix B. Seasonal fish species population estimates (Number per mile) by site.

TN9.3/9.4 AQ5/AQ6 (Reference)	Fall 2014	Summer 2015	Summer 2016	Fall 2016	Summer 2017	Fall 2017	Summer 2018	Summer 2019	Avg.	SE
Brook Trout	0	13	18	18	21	31	0	37	17.2	4.6
Rainbow Trout	312	104	141	231	156	289	52	0	160.6	39.1
RBTxCT Hybrid	65	195	94	436	151	238	32	140	168.9	44.9
Westslope Cutthroat	0	0	0	0	4	0	5	0	1.2	0.8
Rocky Mountain Sculpin	4461	4370	1681	6890	1414	2375	993	816	2875.0	761.4
Total Salmonids	**377**	**312.2**	**252.6**	**684.6**	**332**	**558**	**89.2**	**177**	**347.8**	**68.8**

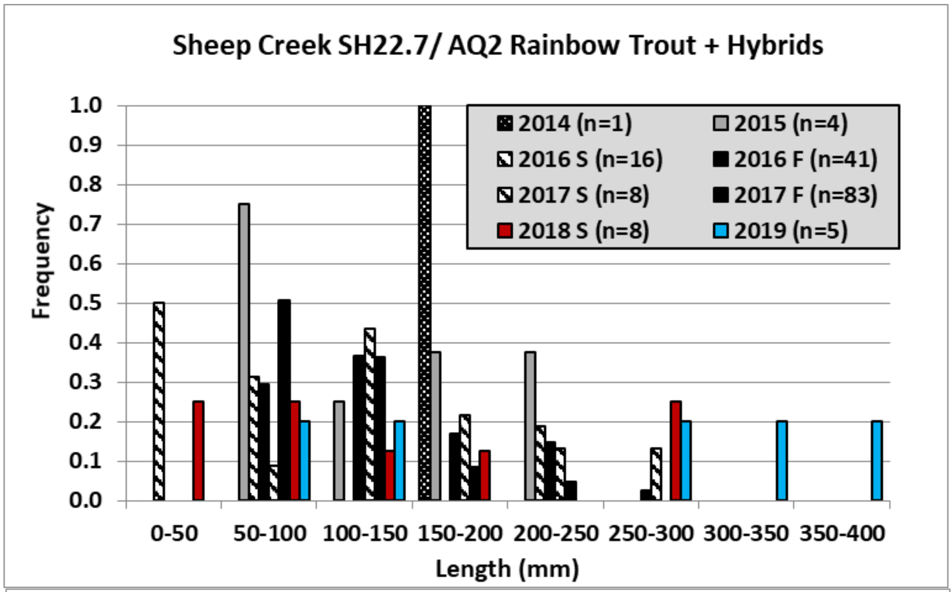
LS0.1/ AQ7 (Impact)	Fall 2014	Spring 2015	Summer 2015	Spring 2016	Summer 2016	Fall 2016	Spring 2017	Summer 2017	Fall 2017	Summer 2018	Summer 2019	Avg.	SE
Brook Trout	478	268	1228	517	797	1795	312	1019	1446	364	312	**776.0**	**158.6**
Rainbow Trout	79	26	53	33	53	13	31	0	10	10	20	**29.9**	**7.1**
Brown Trout	53	40	53	79	13	79	0	0	31	21	83	**41.1**	**9.3**
Mountain Whitefish	0	0	0	0	0	13	0	63	62	0	0	**12.5**	**7.5**
Rocky Mtn. Sculpin	726	310	766	607	964	2455	437	884	1050	364	1466	**911.7**	**184.6**
Total Salmonids	**610**	**334**	**1333**	**630**	**863**	**1901**	**343**	**1082**	**1549**	**395**	**415**	**859.5**	**162.5**

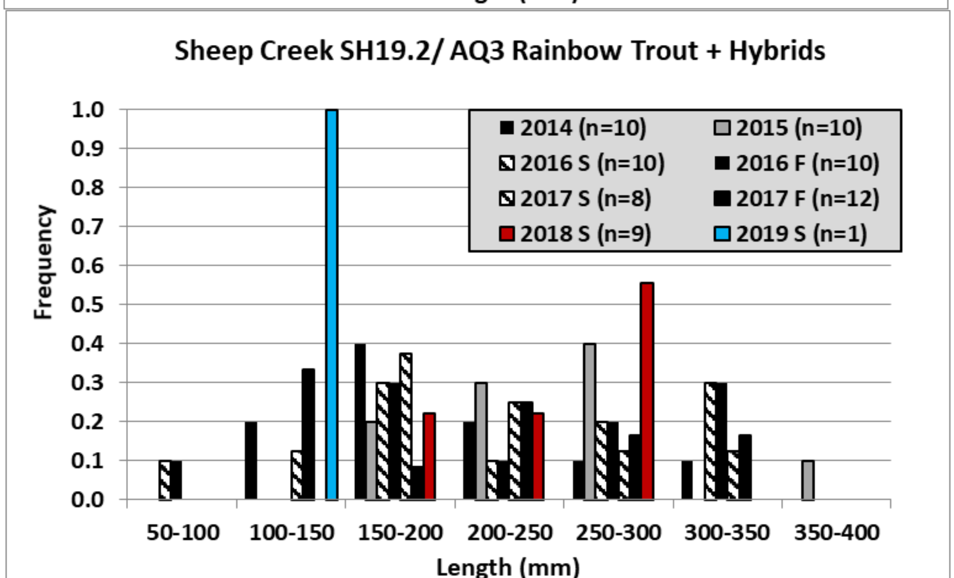
LS.7 / AQ8 (Control)	Fall 2014	Spring 2015	Summer 2015	Spring 2016	Summer 2016	Fall 2016	Spring 2017	Summer 2017	Fall 2017	Summer 2018	Summer 2019	Avg.	se
Brook Trout	106	79	40	132	145	277	63	0	0	104	63	**91.7**	**23.5**
Rocky Mtn. Sculpin	805	620	924	1016	1492	1122	302	697	437	354	499	**751.7**	**110.0**
White Sucker	0	0	0	0	0	13	0	0	0	0	0	**1.2**	**1.2**
Total Salmonids	**106**	**79**	**40**	**132**	**145**	**277**	**63**	**0**	**0**	**104**	**63**	**91.7**	**23.5**

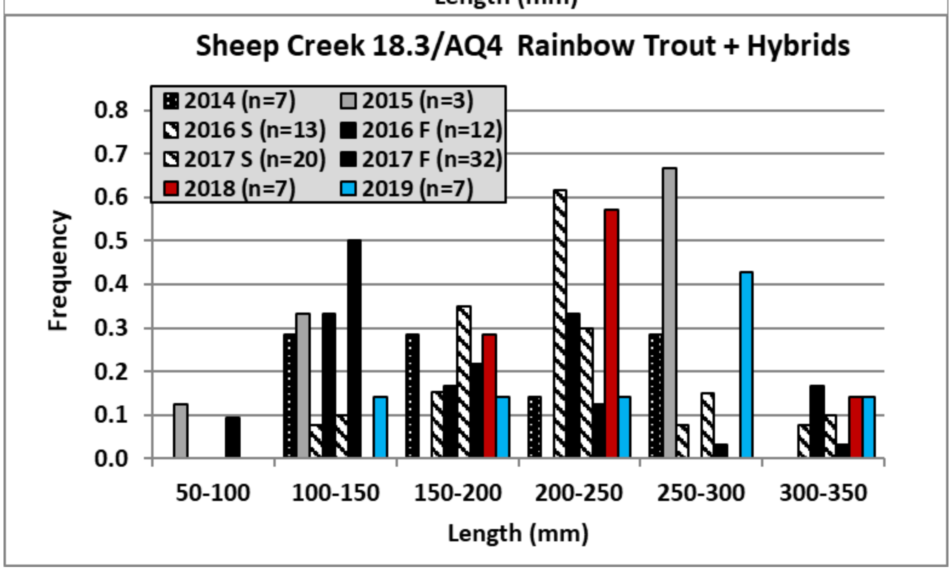
Appendix C

Seasonal Fish Size-Frequency Data

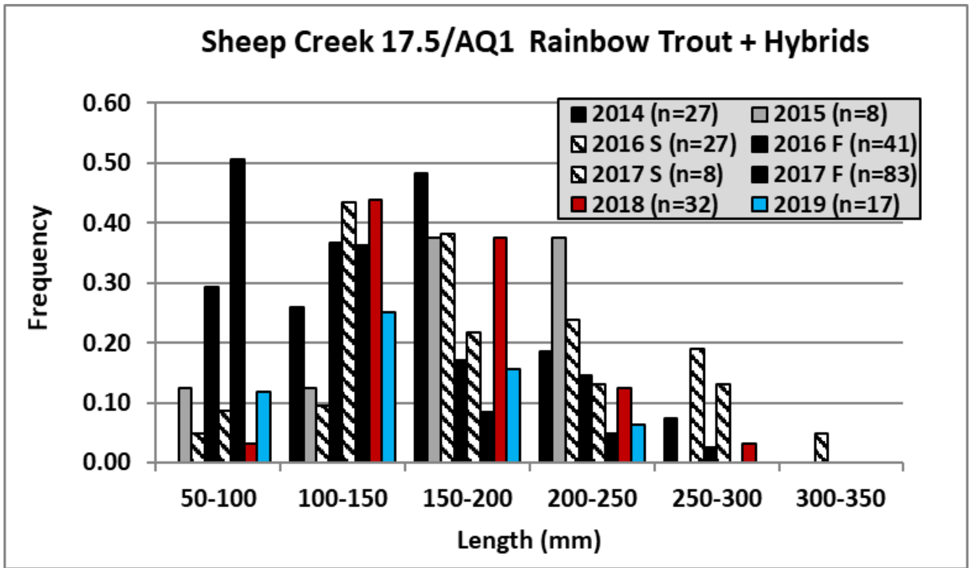
Appendix C. Length-Frequency Graphs for Rainbow Trout or Hybrids across the BBC sites 2014-2019. Catchable size is considered >200mm (8 inches).

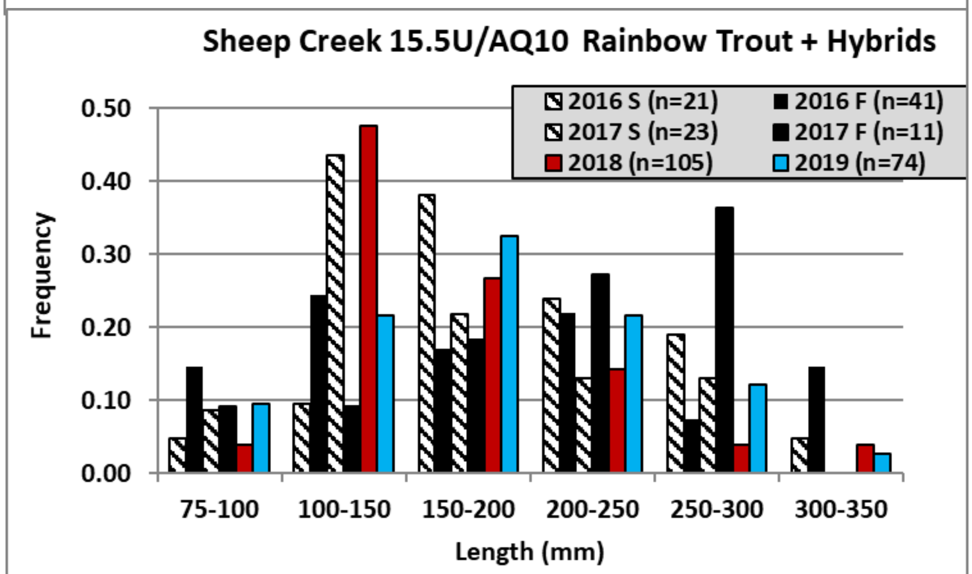


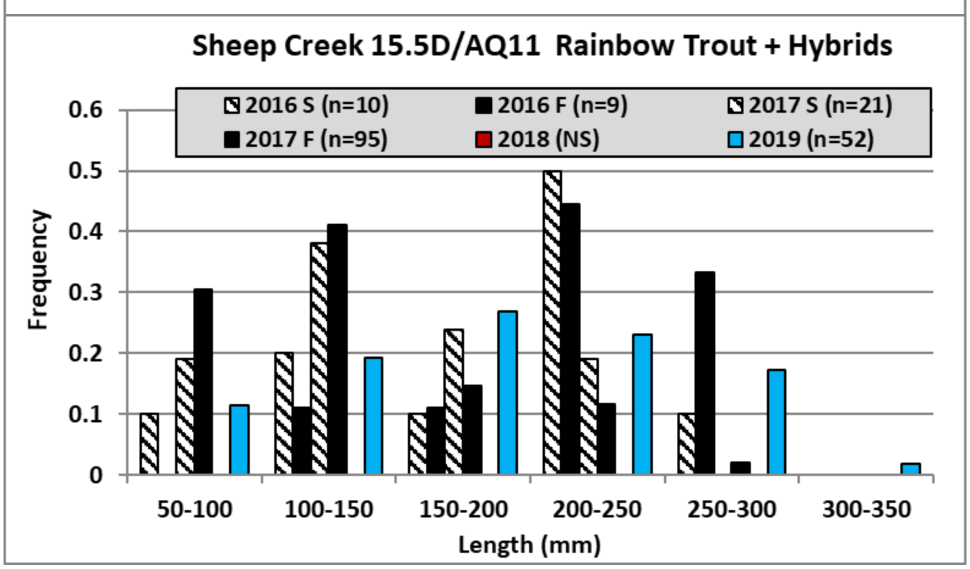




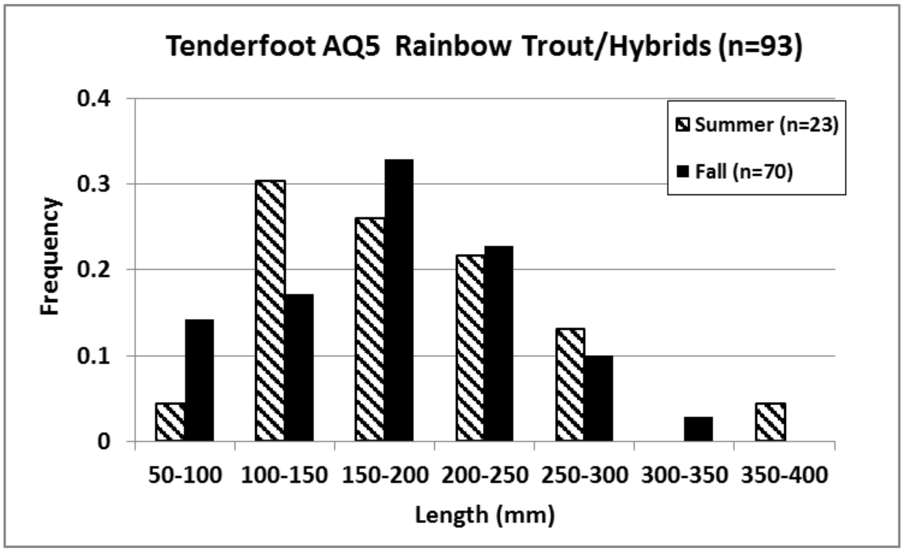
Appendix C. Sheep Creek seasonal rainbow trout (RBTR) size-frequency graphs for 2016-2019. Catchable size is considered >200mm (8 inches).

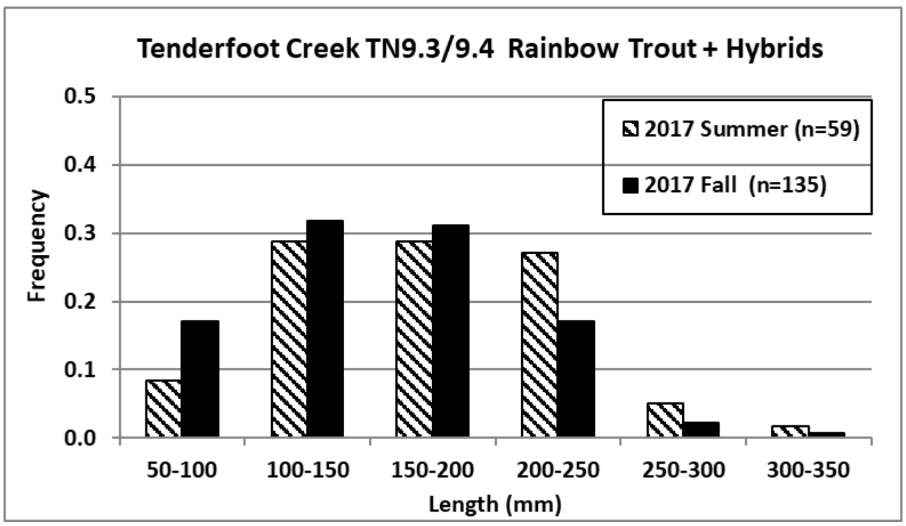


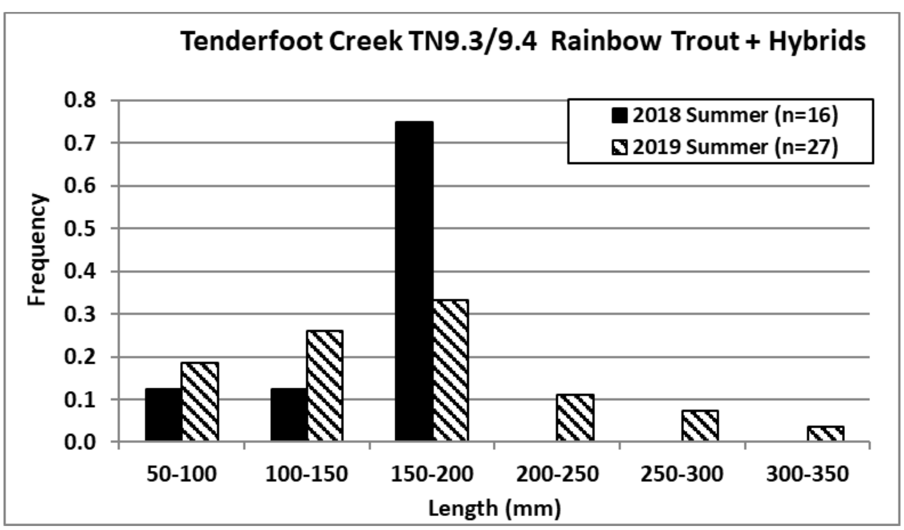




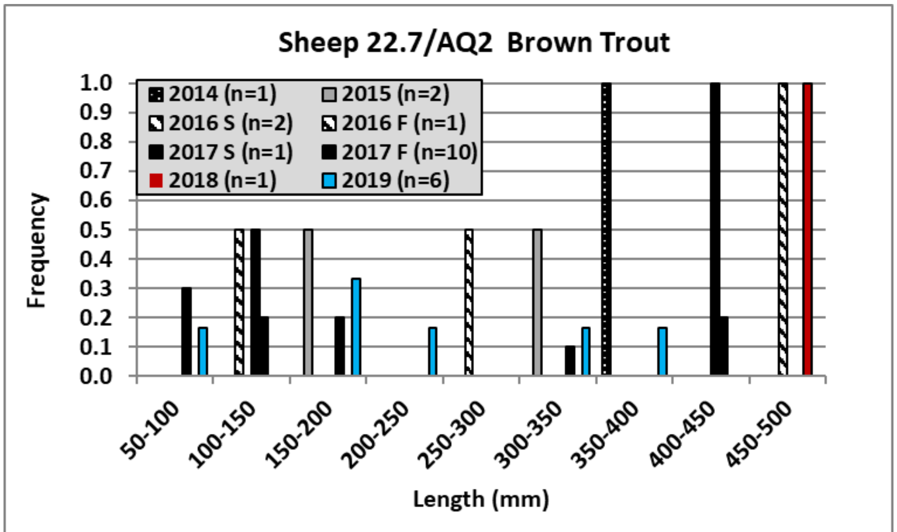
Appendix C. Tenderfoot Creek seasonal rainbow trout or hybrids (RBT/CTxRBT) size-frequency graphs for 2016 (top), 2017 (middle), 2018-2019 (bottom). Catchable size is considered >200mm (8 inches)

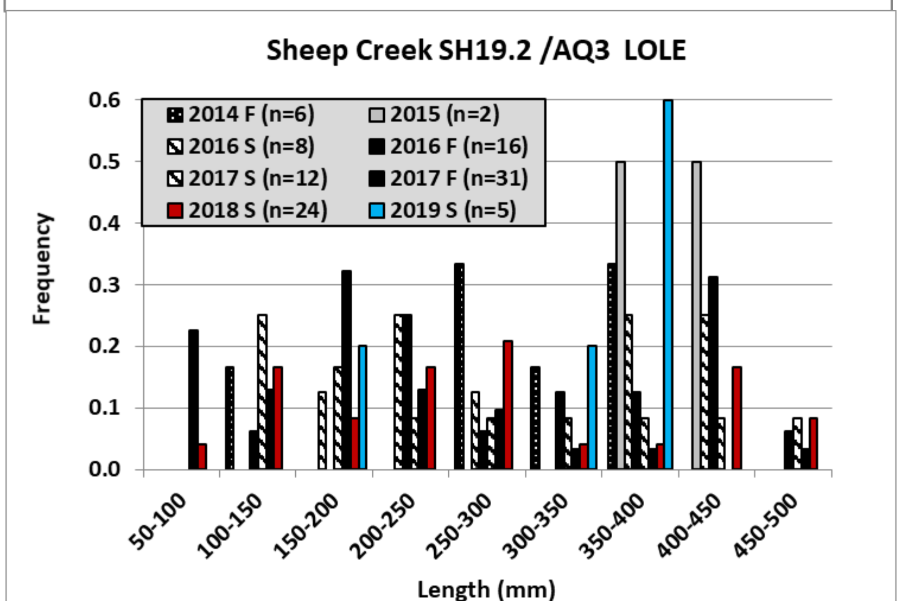


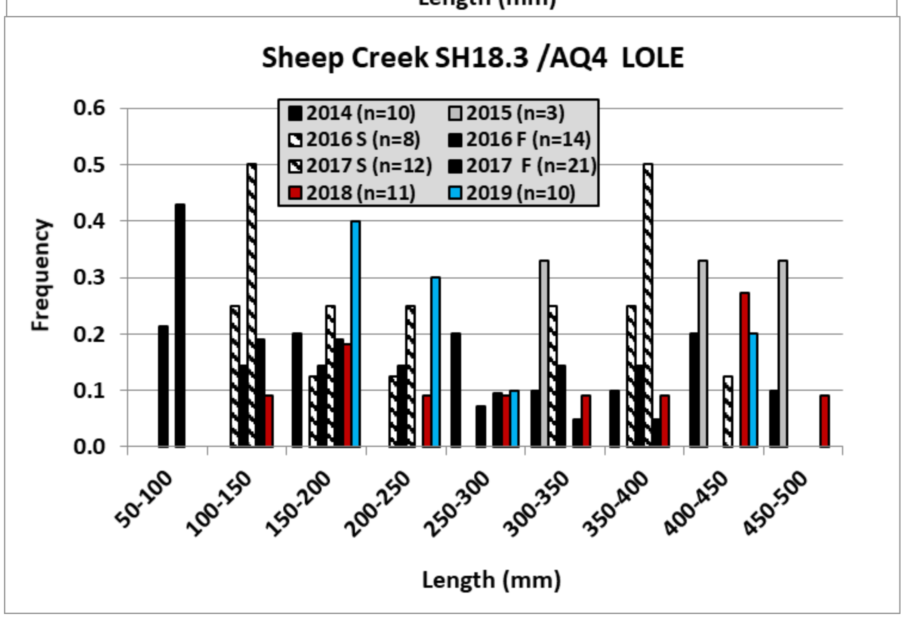




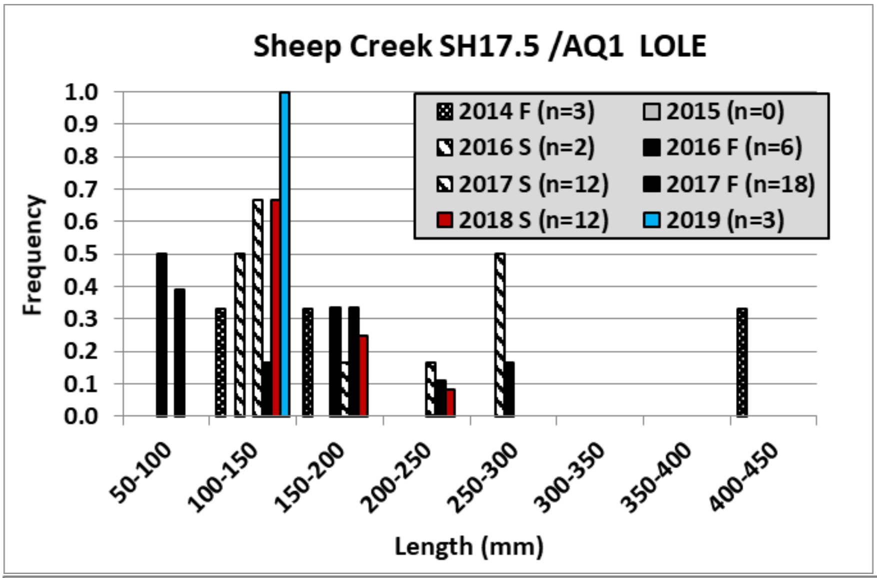
Appendix C. Length-Frequency Graphs for LOLE across the BBC sites 2014-2019. For 2016 and 2017 Summer (S) and Fall (F) surveys are presented.

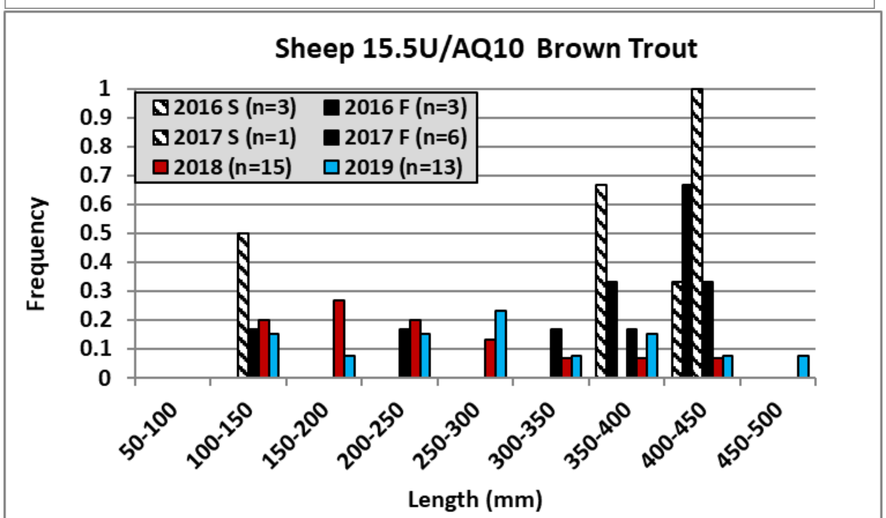


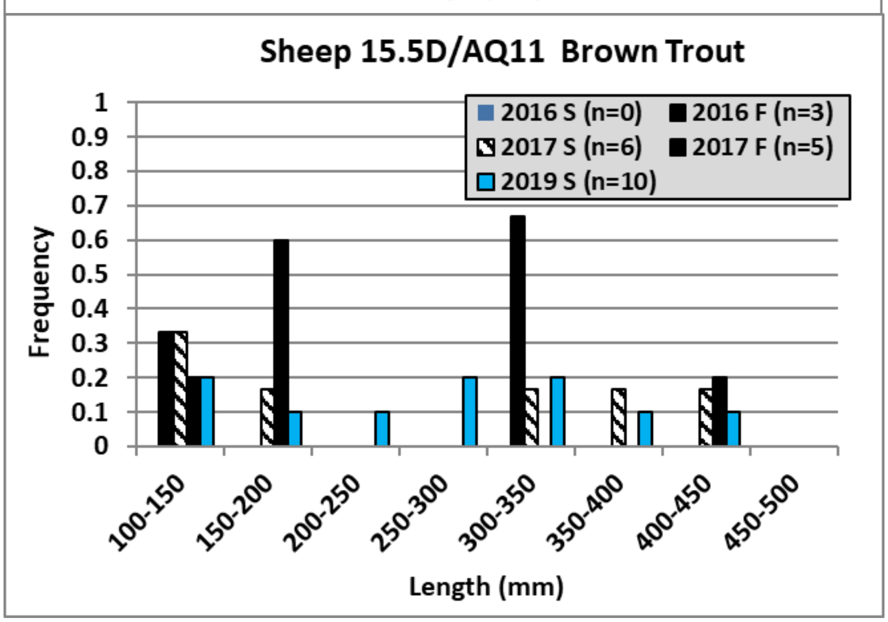




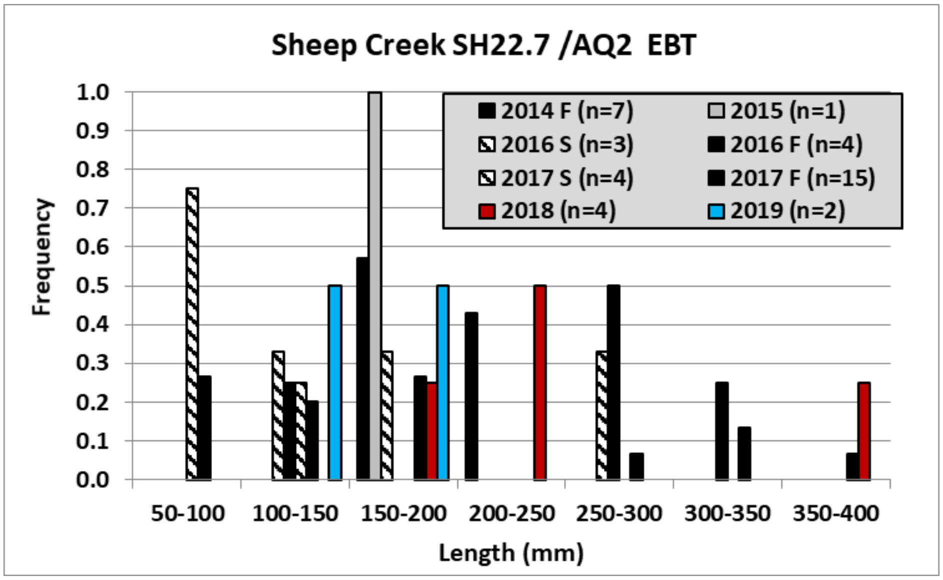
Appendix C. cont. Length-Frequency Graphs for LOLE across the BBC sites 2014-2019. For 2016 and 2017 Summer (S) and Fall (F) surveys are presented.

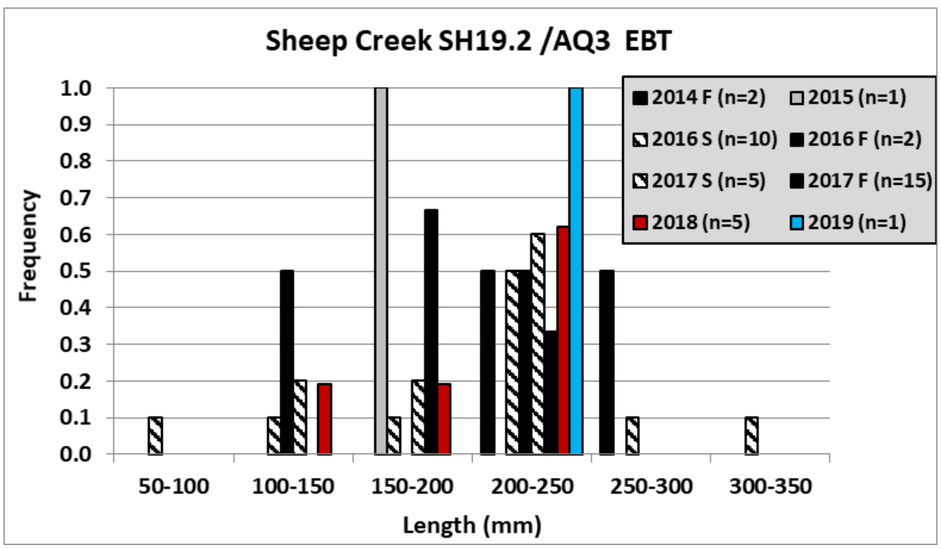


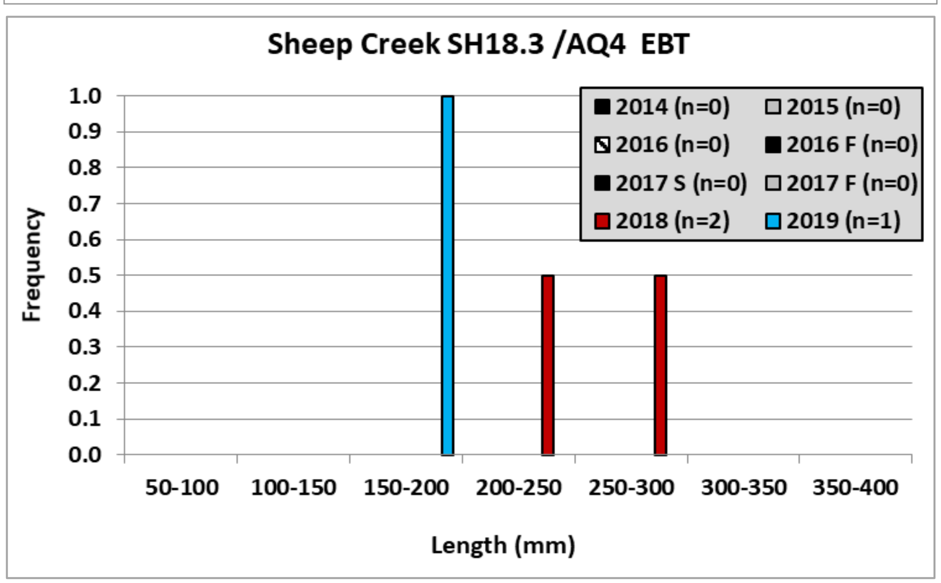




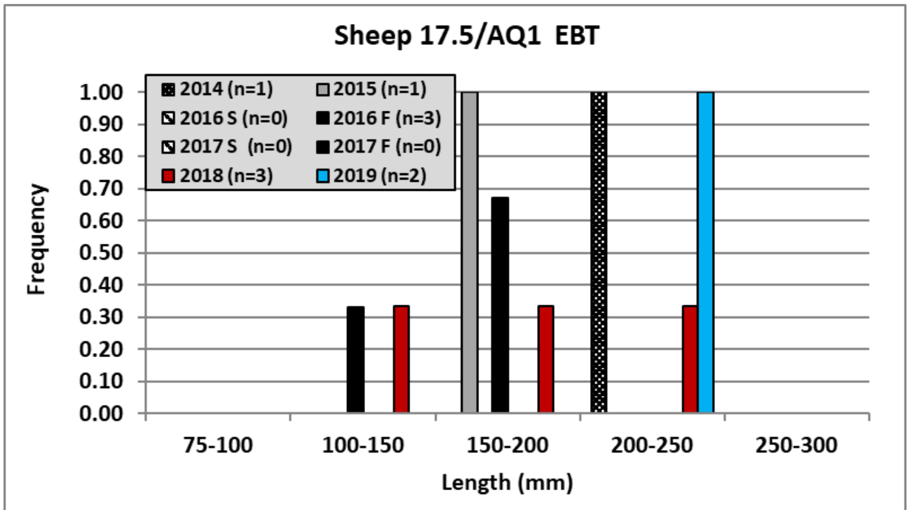
Appendix C. Length-Frequency Graphs for Brook Trout across the BBC sites 2014-2019. Catchable size is considered >200mm (8 inches).

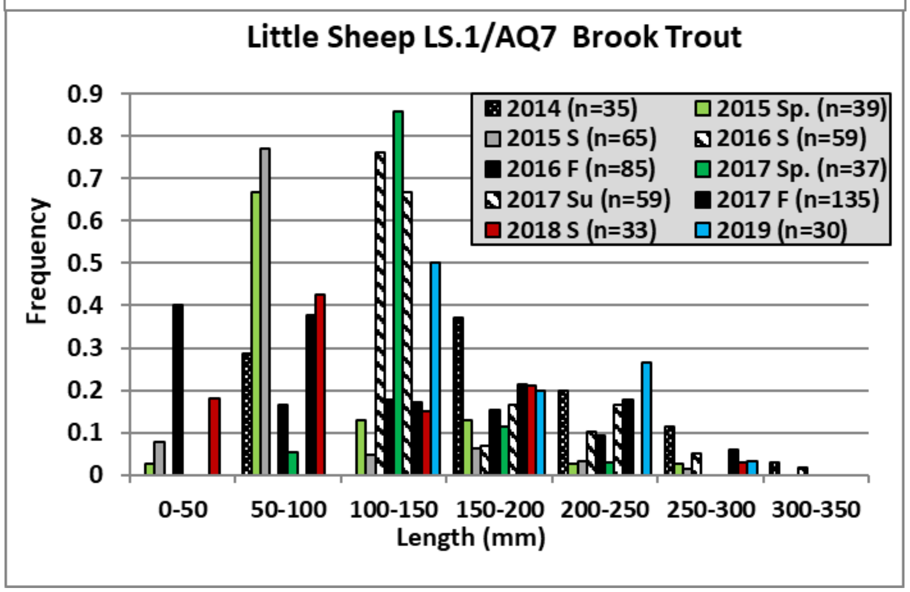


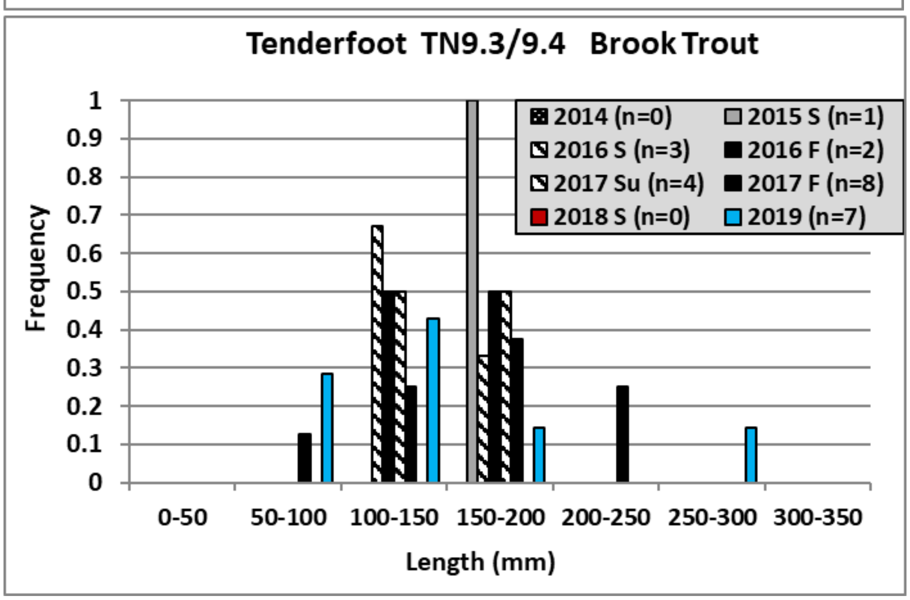




Appendix C. Length-Frequency Graphs for Brook Trout across the BBC sites 2014-2019. Catchable size is considered >200mm (8 inches).







Appendix D
Macroinvertebrate Taxa List, Abundance and Metrics

Appendix D. Macroinvertebrate Metric abundance statistics (Densities: number per meter^2) for the BBC sites. 2016-2019 Average Densities calculated from 3 Hess samples.

	Collection Date				
Station ID-RM	**8/15/2014**	**7/11/2016**	**7/19/2017**	**7/7/2018**	**7/11/2019**
SHEEP AQ2 22.7 (C)	3260	5632	2392	3320	2800
SHEEP AQ3 19.2 (C)	3158	3940	2216	15910	3171
Control (#/m^2 avg.)	**3209.0**	**4786.0**	**2304.0**	**9615.0**	**2985.5**
SHEEP AQ4 18.3 (I)	5872	4630	2364	4776	5783
SHEEP AQ1 17.5 (I)	2952	4335	4288	5673	3987
SHEEP AQ10 15.5U (I)		2044	4808	4290	3105
SHEEP AQ11 15.5D (I)		2760	3256	2857	2999
SHEEP AQ12 0.1 (I)				3340	3130
Impact (#/m2 avg.)	**4412.0**	**3442.3**	**3679.0**	**4187.2**	**3800.8**
TENDER AQ5 9.3 (R')	6080	2224	3880	950	1353
TENDER AQ6 9.4 (R')	7424	2515	3515	1110	2023
Reference (#/m2 avg.)	**6752.0**	**2369.5**	**3697.5**	**1030.0**	**1688.0**
L. SHEEP AQ7 0.1 (I)	3040	2612	4080	4880	4086
L. SHEEP AQ8 0.7 (C')	1132	1136	1152	1008	993
L. Sheep (#/m2 avg.)	**2086.0**	**1874.0**	**2616.0**	**2944.0**	**2539.5**
COON AQ9* 0.5 (I)	2520	1992	1412	2040	1394
Overall (#/m2 avg.)	**3544.0**	**3107.0**	**3336.3**	**4245.0**	**2864.0**
* Coon Creek bug sampling initiated in 2015					

Appendix D. Macroinvertebrate DEQ Mountain MMI scores calculated from 2014 to 2019. 2014 scores were from the DEQ RW EMAP samples while 2016-2018, Hess samples (n=3) were used to calculate MMI scores. Bolded, underlined scores > 63 are considered non-impaired communities.

	Collection Date				
Station ID-RM	**8/14-8/15 2014 [1]**	**7/11-7/14 2016**	**7/19 + 7/20 2017**	**7/6-7/9 2018**	**7/11-7/15 2019**
SH22.7 AQ2 (C)	**63.3**	**70.1**	**64.6**	**69.2**	**69.2**
SH19.2 AQ3 (C)	55.8	53.7	55.1	48.9	**67.6**
Control (MMI avg.)	**59.5**	**61.9**	**59.9**	**59.1**	**68.4**
SH18.3 AQ4 (I)	62.7	60.8	61.9	51.7	60.4
SH17.5 AQ1 (I)	**63.7**	**65.5**	60.7	45.7	54.1
SH15.5U AQ10 (I)		**65.8**	58.2	**63.6**	60.9
SH15.5D AQ11 (I)		60.1	**65.1**	62.4	**65.8**
SH 0.1 AQ12 (I)				**63.8**	**66.6**
Impact (MMI avg.)	**63.2**	**63.0**	**61.5**	**57.4**	**61.6**
TN9.3 AQ5 (R')	**68.6**	**68.12**	**67.5**	**64.3**	58.2
TN9.4 AQ6 (R')	**71.4**	**72.76**	**72.8**	**73.2**	59.4
Reference (MMI avg.)	**70.0**	**70.4**	**70.1**	**68.7**	**58.8**
LS.1 AQ7 (I)	39.7	61.1	47.4	42.4	54.9
LS.6 AQ8 (C)	46.9	39.7	30.1	37.2	27.39
L. Sheep (MMI avg.)	**43.3**	**50.4**	**38.8**	**39.8**	**41.1**
CN 0.5 AQ9* (I)	48.5	51	56.0	43.3	59.11
Overall (MMI avg.)	**57.8**	**66.4**	**63.6**	**60.4**	**58.3**
[1] 2014 MMI s were calculated from the DEQ EMAP samples while in 2016-2018, Hess samples were used to calculate MMIs					
* Coon Creek bug sampling was initiated in 2015					

Appendix D. Macroinvertebrate DEQ Low Valley MMI scores calculated from 2014 to 2019. 2014 scores were from the DEQ RW EMAP samples while 2016-2018, Hess samples (n=3) were used to calculate MMI scores. Bolded, shaded scores <48 are considered impaired communities. RM-river mile

	Collection Date				
Station ID-RM	**8/14-8/15 2014** [1]	**7/11-7/14 2016**	**7/19 + 7/20 2017**	**7/6-7/9 2018**	**7/11-7/15 2019**
SH22.7 AQ2 (C)	57.3	60.8	64.0	62.1	63.3
SH19.2 AQ3 (C)	49.4	53.7	53.6	60.7	61.7
Control (MMI avg.)	**53.3**	**57.2**	**58.8**	**61.4**	**62.5**
SH18.3 AQ4 (I)	60.4	68.2	52.4	64.9	59.9
SH17.5 AQ1 (I)	50.3	70.5	54.4	57.3	56.7
SH15.5U AQ10 (I)		53.3	60.8	62.9	64.4
SH15.5D AQ11 (I)		70.2	58.7	60.4	62.1
SH 0.1 AQ12 (I)				53.5	60.2
Impact (MMI avg.)	**55.3**	**65.5**	**56.6**	**59.8**	**60.7**
TN9.3 AQ5 (R')	78.6	65.1	53.1	60.2	60.8
TN9.4 AQ6 (R')	75.4	67.2	62.3	65.4	60.2
Reference (MMI avg.)	**77.0**	**66.2**	**57.7**	**62.8**	**60.5**
LS.1 AQ7 (I)	54.7	53.9	48.6	58.8	59.5
LS.6 AQ8 (C)	49.0	**<u>39.7</u>**	**<u>31.1</u>**	**<u>33.1</u>**	**59.7**
L. Sheep (MMI avg.)	**51.8**	**<u>46.8</u>**	**<u>39.9</u>**	**<u>45.9</u>**	**59.6**
CN 0.5 AQ9***** (I)	59.2	54.1	56.0	56.2	50.4
Overall (MMI avg.)	**59.4**	**59.7**	**54.1**	**58.0**	**59.9**

[1] 2014 MMI s were calculated from the DEQ EMAP samples while in 2016-2018, Hess samples were used to calculate MMIs

***** Coon Creek bug sampling was initiated in 2015

Appendix D. cont. Average Total macroinvertebrate taxa richness per sample from 2014 to 2019. Bolded, underlined Total Taxa > 40 are considered non-impaired mountain communities.

	Collection Date				
Station ID-RM	**8/14-8/15 2014** [1]	**7/11-7/14 2016**	**7/19 + 7/20 2017**	**7/6-7/9 2018**	**7/11-7/15 2019**
SHEEP 22.7 (C) AQ2	**47**	**59**	**57**	**41**	**40**
SHEEP 19.2 (C) AQ3	39	35	**42**	**48**	**51**
Control (avg. TTaxa)	**43.0**	**47.0**	**49.5**	**44.5**	**45.5**
SHEEP 18.3 (I) AQ4	**60**	**64**	**46**	**46**	39
SHEEP 17.5 (I) AQ1	**44**	**58**	**42**	**42**	37
SHEEP 15.5U(I) AQ10		**55**	**55**	**52**	**41**
SHEEP 15.5D(I) AQ11		**45**	**47**	**55**	33
SHEEP 0.1 (I) AQ12				**43**	**43**
Impact (avg. TTaxa)	**52**	**55.5**	**47.5**	**47.6**	38.6
TENDER 9.3 (R)	**53**	**46**	**47**	**52**	24
TENDER 9.4 (R)	**43**	**42**	**48**	**50**	29
Reference (avg. TTaxa)	**48.0**	**44**	**47.5**	**51.0**	26.5
L. SHEEP 0.1 (I) AQ7	35	**45**	**53**	**44**	32
L. SHEEP 0.7(C) AQ8	37	29	**45**	**43**	38
L. Sheep (avg. TTaxa)	36	37	**49.0**	**43.5**	35.0
COON 0.5 (I) AQ9*	36	35	39	39	50
Overall (avg. TTaxa)	**44.1**	**46.4**	**47.6**	**46.4**	37.7

[1] 2014 Total taxa were estimated from the DEQ EMAP samples while in 2016-2019, Hess samples (n=3) were used to calculate Total taxa richness

* Coon Creek bug sampling was initiated in 2015

Appendix D. (Cont.) Average EPT taxa richness per sample from 2014 to 2019. 2014 scores were calculated from the DEQ RW EMAP samples while 2016-2019, Hess samples (n=3) were used to calculate EPT taxa. Bolded, underlined EPT taxa >20 are considered non-impaired communities. RM-river mile

	Collection Date				
Station ID-RM	**8/14-8/15 2014** [1]	**7/11-7/14 2016**	**7/19 + 7/20 2017**	**7/6-7/9 2018**	**7/11-7/12 2019**
SH22.7 AQ2 (C)	19	**27**	**29**	**24.2**	**22.3**
SH19.2 AQ3 (C)	16	16	17	17.8	**25.0**
Control (EPT avg.)	17.5	**21.5**	**23.0**	**21.0**	**23.7**
SH18.3 AQ4 (I)	**21**	**24**	**22**	**21.4**	19.0
SH17.5 AQ1 (I)	**21**	**29**	**21**	16.7	15.7
SH15.5U AQ10 (I)		**30**	**22**	18.5	**21.7**
SH15.5D AQ11 (I)		**23**	**27**	**22.0**	19.5
SH 0.1 AQ12 (I)				**24.6**	**23.0**
Impact (EPT avg.)	**21**	**26.5**	**23.0**	**20.6**	**19.8**
TN9.3 AQ5 (R)	**23**	**24**	**25**	**21.3**	14.0
TN9.4 AQ6 (R)	**22**	**22**	**23**	**22.0**	15.3
Reference (EPT avg.)	**22.5**	**23**	**24.0**	**21.6**	14.7
LS.1 AQ7 (I)	9	**21**	**22**	11.0	15.2
LS.6 AQ8 (C)	10	9	11	9.0	11.0
L. Sheep (EPT avg.)	10	15	16.5	10.0	13.1
CN 0.5 AQ9* (I)	14	12	14.0	12.0	18.0
Overall Sites (avg. EPT)	**18.4**	**21.5**	**21.3**	18.0	19.5

[1] 2014 EPT taxa were estimated from the DEQ EMAP samples while in 2016-2019, Hess samples were used to calculate EPT taxa richness

* Coon Creek bug sampling was initiated in 2015

Appendix D. (cont.) Average % EPT per macroinvertebrate sample from 2014 to 2019. Bolded, shaded % EPT scores > 70 are considered healthy mountain stream communities.

	Collection Date				
Station ID-RM	8/14-8/15 2014[1]	7/11-7/14 2016	7/19 + 7/20 2017	7/6-7/9 2018	7/11-7/15 2019
SH22.7 AQ2 (C)	60.0	63.6	56.7	65.3	68.8
SH19.2 AQ3 (C)	26.9	36.8	42.4	43.4	55.4
Control (%EPT avg.)	43.5	50.2	49.6	54.3	62.1
SH18.3 AQ4 (I)	47.0	25.5	47.2	34.0	60.9
SH17.5 AQ1 (I)	48.8	65.2	64.0	32.4	51.6
SH15.5U AQ10 (I)		53.9	62.1	40.9	58.3
SH15.5D AQ11 (I)		51.6	52.4	59.3	**80.8**
SH 0.1 AQ12 (I)				61.2	51.0
Impact (% EPT avg.)	47.9	49.1	56.4	45.6	60.5
TN9.3 AQ5 (R)	33.8	67.7	51.4	67.3	45.5
TN9.4 AQ6 (R)	48.4	62.6	55.0	**70.0**	47.3
Reference (% EPT avg.)	41.1	65.2	53.2	68.6	46.4
LS.1 AQ7 (I)	12.1	52.7	37.6	17.0	68.0
LS.6 AQ8 (C)	24.7	9.9	22.0	9.4	18.1
L. Sheep (% EPT avg.)	18.4	31.3	29.8	13.2	43.1
CN 0.5 AQ9* (I)	35.5	15.5	47.6	22.9	31.2
Overall Sites (avg.% EPT)	37.5	45.9	48.9	43.3	53.1

[1] 2014 %EPT were estimated from the DEQ EMAP samples while in 2016-2018, Hess samples (n=3) were used to calculate %EPT

* Coon Creek bug sampling was initiated in July 2015

Appendix D. (cont.) Average % Non-Insect composition per macroinvertebrate sample from 2014 to 2019. Bolded, shaded Non-Insect > 10% are considered impaired for mountain stream communities.

	Collection Date				
Station ID-RM	**8/14-8/15 2014 [1]**	**7/11-7/14 2016**	**7/19 + 7/20 2017**	**7/6-7/9 2018**	**7/11-7/15 2019**
SH22.7 AQ2 (C)	**3.4**	**0.57**	**5.0**	**8.2**	**2.5**
SH19.2 AQ3 (C)	**0.51**	**1.3**	**1.6**	**3.3**	**2.1**
Control (% Non-Inst avg.)	**2.0**	**0.9**	**3.3**	**5.7**	**2.3**
SH18.3 AQ4 (I)	**3.1**	**4.1**	**0.5**	**2.4**	**2.4**
SH17.5 AQ1 (I)	**1.9**	**2.3**	**2.6**	**3.0**	**3.0**
SH15.5U AQ10 (I)		**0.9**	**2.0**	**6.0**	**2.2**
SH15.5D AQ11 (I)		**4.8**	**1.0**	**2.8**	**0.7**
SH 0.1 AQ12 (I)				**2.0**	**2.0**
Impact (% Non-Inst avg.)	**2.5**	**3.0**	**1.5**	**3.3**	**2.1**
TN9.3 AQ5 (R)	**1.1**	**0.2**	**0.0**	**0.5**	**0.2**
TN9.4 AQ6 (R)	**1.0**	**0.3**	**0.1**	**0.3**	**0.2**
Reference (% Non-Inst avg.)	**1.1**	**0.3**	**0.1**	**0.4**	**0.2**
LS.1 AQ7 (I)	**9.8**	**5.2**	**18.1**	**22.8**	**9.5**
LS.6 AQ8 (C)	**19.4**	**9.9**	**47.0**	**48.2**	**33.5**
L. Sheep (% Non-Inst avg.)	**14.6**	**7.5**	**32.5**	**35.5**	**21.5**
CN 0.5 AQ9* (I)	**17.0**	**3.4**	**4.3**	**13.4**	**4.1**
Overall (avg.% Non-Inst)	**7.0**	**3.3**	**8.2**	**9.5**	**5.5**

[1] 2014 % Non-Insect were estimated from the DEQ EMAP samples while in 2016-2018, Hess samples (n=3) were used to calculate % Non-insect

* Coon Creek bug sampling was initiated in July 2015

Appendix D. (cont.) Average % Heptageniidae per macroinvertebrate sample from 2014 to 2019. Bolded, shaded Heptageniidae scores > 5% are considered healthy mountain stream communities.

	Collection Date				
Station ID-RM	**8/14-8/15 2014 [1]**	**7/11-7/14 2016**	**7/19 + 7/20 2017**	**7/6-7/9 2018**	**7/11-7/15 2019**
SHEEP AQ2 22.7 (C)	**0.0**	**0.6**	**0.3**	**4.0**	**2.1**
SHEEP AQ3 19.2 (C)	**0.3**	**0.0**	**0.02**	**0.8**	**1.6**
Control (avg. % Heptag)	**0.15**	**0.30**	**0.16**	**2.4**	**1.9**
SHEEP AQ4 18.3 (I)	**0.3**	**0.3**	**1.0**	**1.2**	**1.9**
SHEEP AQ1 17.5 (I)	**0.0**	**0.36**	**0.9**	**1.4**	**1.4**
SHEEP AQ10 15.5U (I)		**0.55**	**0.5**	**1.1**	**1.7**
SHEEP AQ11 15.5D (I)		**0.29**	**0.7**	**0.9**	**0.8**
SHEEP AQ12 0.1 (I)				**3.2**	**2.4**
Impact (avg. % Heptag)	**0.15**	**0.38**	**0.8**	**1.6**	**1.6**
TENDER AQ5 9.3 (R)	**0.25**	**0.4**	**5.5**	**4.3**	**2.9**
TENDER AQ6 9.4 (R)	**0.5**	**0.6**	**5.1**	**4.1**	**4.1**
Reference (avg. % Heptag)	**0.4**	**0.5**	**5.3**	**4.2**	**3.5**
L. SHEEP AQ7 0.1 (I)	**1.3**	**1.4**	**14.9**	**1.8**	**0.1**
L. SHEEP AQ8 0.7 (C)	**0.53**	**0.0**	**0.23**	**0.0**	**0.0**
L. Sheep (avg. % Heptag)	**0.9**	**0.7**	**7.6**	**0.9**	**0.0**
COON AQ9***** 0.5 (I)	**0.0**	**0.4**	**0.0**	**0.8**	**1.7**
Overall (avg. % Heptag)	**0.3**	**0.4**	**2.4**	**1.8**	**1.9**

[1] 2014 % Heptageniidae were estimated from the DEQ EMAP samples while in 2016-2019, Hess samples (n=3) were used to calculate % Heptageniidae

***** Coon Creek bug sampling was initiated in July 2015

Appendix D. (cont.) Average % Chironomidae per macroinvertebrate sample from 2014 to 2019. Bolded, shaded Chironomidae scores <20% are considered healthy mountain stream communities.

	Collection Date				
Station ID-RM	**8/14-8/15 2014[1]**	**7/11-7/14 2016**	**7/19 + 7/20 2017**	**7/6-7/9 2018**	**7/11-7/15 2019**
SH22.7 AQ2 (C)	9.9	14.2	7.9	14.2	14.8
SH19.2 AQ3 (C)	6.6	12.4	12.7	12.4	19.7
Control (%EPT avg.)	**8.3**	**13.3**	**10.3**	**13.3**	**17.3**
SH18.3 AQ4 (I)	12.0	25.5	11.7	23.8	13.3
SH17.5 AQ1 (I)	8.1	8.5	3.4	3.4	20.0
SH15.5U AQ10 (I)		6.6	6.7	15.5	23.8
SH15.5D AQ11 (I)		10.3	16.5	11.7	6.1
SH 0.1 AQ12 (I)				14.2	27.0
Impact (% EPT avg.)	**10.0**	**12.7**	**9.6**	**13.7**	**18.0**
TN9.3 AQ5 (R)	**53.0**	28.0	6.6	19.3	12.9
TN9.4 AQ6 (R)	**37.1**	23.5	6.2	17.5	12.5
Reference (% EPT avg.)	**45.1**	**25.8**	**6.4**	**18.4**	**12.7**
LS.1 AQ7 (I)	**12.1**	24.4	15.8	17.0	11.5
LS.6 AQ8 (C)	**24.7**	9.9	12.2	9.4	18.1
L. Sheep (% EPT avg.)	**18.4**	**17.1**	**14.0**	**13.2**	**14.8**
CN 0.5 AQ9* (I)	**26.2**	15.5	23.8	44.3	31.2
Overall Sites (avg.% EPT)	**21.1**	**16.3**	**11.2**	**16.9**	**17.6**

[1] 2014 %EPT were estimated from the DEQ EMAP samples while in 2016-2018, Hess samples (n=3) were used to calculate %EPT

***** Coon Creek bug sampling was initiated in July 2015

Appendix D. Macroinvertebrate Metric statistical Student-T test results by stream and treatments from 2014 (top) to 2018 (bottom). Underlined and bolded values were significant at $p < 0.05$.

2014	Ind m^{-2}	Mtn MMI Index	LVAL MMI Index	Total Taxa	EPT Taxa	% EPT	HBI	% Hepta
Tenderfoot x Sheep	**0.03**	**0.02**	**0.003**	0.47	0.19	0.35	0.23	0.49
Sheep x L. Sheep	0.110	**0.004**	0.30	0.08	**0.01**	**0.03**	**0.004**	0.08
Tenderfoot x L. Sheep	**0.03**	**0.01**	**0.01**	0.07	**0.004**	**0.07**	0.16	0.20
Treatment X Control	0.25	0.41	0.34	0.28	0.30	0.48	0.46	0.38
Treatment X Reference	0.06	**0.032**	**0.01**	0.47	0.18	0.41	0.24	0.38
Control X Reference	**0.017**	0.06	**0.02**	0.26	0.06	0.45	0.28	0.50

2016	Ind m^{-2}	Mtn MMI Index	LVAL MMI Index	Total Taxa	EPT Taxa	% EPT	HBI	% Hepta
Tenderfoot x Sheep	0.19	0.06	0.14	0.18	0.19	0.31	0.27	**0.04**
Sheep x L. Sheep	0.11	0.06	**0.03**	0.06	**0.01**	0.16	0.49	**0.04**
Tenderfoot x L. Sheep	0.29	0.10	0.07	0.23	**0.004**	0.25	0.24	0.21
Treatment X Control	**0.05**	0.42	0.31	0.21	0.47	0.35	0.43	0.24
Treatment X Reference	0.34	**0.02**	0.23	0.07	0.32	0.14	0.27	0.10
Control X Reference	**0.05**	0.21	0.13	0.43	0.37	0.19	0.36	0.19

2017	Ind m^{-2}	Mtn MMI Index	LVAL MMI Index	Total Taxa	EPT Taxa	% EPT	HBI	% Hepta
Tenderfoot x Sheep	0.17	**0.01**	0.14	0.18	0.44	0.34	**0.05**	**0.02**
Sheep x L. Sheep	0.09	**0.002**	**0.03**	0.06	**0.08**	**0.01**	**0.001**	**0.05**
Tenderfoot x L. Sheep	0.29	**0.04**	0.07	0.23	**0.214**	**0.05**	**0.02**	0.32
Treatment X Control	0.08	0.34	0.31	0.21	0.50	0.20	0.27	0.17
Treatment X Reference	**0.03**	**0.04**	**0.07**	0.11	0.40	0.36	0.11	0.09
Control X Reference	**0.37**	0.10	0.13	0.43	0.47	0.25	0.15	0.20

2018	Ind m^{-2}	MTN MMI Index	LVAL MMI Index	Total Taxa	EPT Taxa	% EPT	HBI	% Hepta
Tenderfoot x Sheep	**0.01**	**0.03**	0.43	0.41	0.28	0.35	0.49	0.14
Sheep x L. Sheep	0.15	**0.003**	**0.003**	0.19	**0.01**	**0.03**	**0.02**	0.21
Tenderfoot x L. Sheep	**0.20**	**0.002**	**0.0004**	**0.002**	**0.003**	**0.002**	0.10	0.46
Treatment X Control	0.23	0.16	0.19	0.25	0.32	0.16	0.38	0.14
Treatment X Reference	**0.009**	**0.02**	**0.02**	0.25	0.22	**0.03**	0.13	**0.0001**
Control X Reference	**0.05**	0.10	0.10	0.46	0.47	0.18	0.36	0.33

Appendix D. Macroinvertebrate Metric statistical Student-T test results by stream and treatments from 2019. Underlined and bolded values were significant at $p < 0.05$.

2019	Ind m^{-2}	MTN MMI Index	LVAL MMI Index	Total Taxa	EPT Taxa	% EPT	HBI	% Hepta
Tenderfoot x Sheep	**<u>0.03</u>**	0.21	0.33	**<u>0.01</u>**	**<u>0.03</u>**	**<u>0.04</u>**	0.26	**<u>0.002</u>**
Sheep x L. Sheep	0.18	**<u>0.016</u>**	**<u>0.029</u>**	0.16	**<u>0.01</u>**	0.11	**<u>0.05</u>**	**<u>0.002</u>**
Tenderfoot x L. Sheep	0.32	0.164	0.19	0.08	0.28	0.45	0.12	**<u>0.014</u>**
Treatment X Control	0.18	0.16	0.50	0.07	**<u>0.04</u>**	0.47	0.49	0.18
Treatment X Reference	**<u>0.041</u>**	0.35	0.37	**<u>0.01</u>**	**<u>0.04</u>**	0.08	0.29	**<u>0.008</u>**
Control X Reference	**<u>0.039</u>**	0.08	0.18	**<u>0.04</u>**	**<u>0.01</u>**	0.07	0.31	0.06

Appendix E

Periphyton Taxa List, Abundance and Metrics

Analysis of biological samples:
Technical summary of methods and procedures
Prepared for Montana Biological Survey
David Stagliano, Project Manager
December 6, 2019

by
W. Bollman, Chief Biologist
Rhithron Associates, Inc.
Missoula, Montana

METHODS

Eleven periphyton samples, collected for the Black Butte Mine project were delivered to Rhithron's laboratory facility in Missoula, Montana on August 8, 2019. All samples arrived in good condition. An inventory spreadsheet was provided by the Montana Biological Survey Project Manager. Upon arrival, samples were unpacked and examined, and checked against the inventory. Sample metadata was uploaded to the Rhithron database.

The periphyton samples were preserved with formalin, and initial sample volumes were measured and recorded. The samples were thoroughly mixed by shaking, and split into 2 aliquots for diatom and soft-bodied algae analyses.

Permanent diatom slides were prepared: subsamples were taken and treated with 70% Nitric acid (HNO_3) and digested using a closed-vessel microwave digestion system (Milestone Ethos EZ), following the method developed by the Academy of Natural Sciences, Philadelphia (ANSP 2002). The samples were neutralized by rinses with distilled water, and subsample volumes were adjusted to obtain adequate densities for slide mounts. Dilution and concentration factors, as appropriate, were recorded for each sample. Subsamples were dried onto 22-mm square coverslips. Coverslips were mounted on slides using Naphrax diatom mount. To ensure a high quality mount for identification and to make replicates available for archives, 3 slide mounts were made from each sample. One of the replicates was selected from each sample batch for identification. A diamond scribe mark was made to define a transect line on the cover slip, and a minimum of 800 diatom valves were identified along the transect mark. A Leica DM 2500 compound microscope, Nomarski contrast, and 1000x magnification were used for identifications. Diatoms were identified to the lowest possible taxonomic level, generally species, following standard taxonomic references.

For soft-bodied algae samples, the raw periphyton aliquot was manually homogenized and emptied into a porcelain evaporating dish. A small, random sub-sample of algal material was pipetted into a standard Palmer-Maloney counting chamber using a disposable Pasteur pipette. Visible (macroscopic) algae were also sub-sampled, in proportion to their estimated importance relative to the total volume of algal material in the sample, and added to the liquid fraction on the slide. The Palmer-Maloney cell was then covered with a 22 x 30 mm coverslip.

Soft-bodied algae were identified to genus using a Leica DM 2500 compound microscope under 200X and 400X. The relative abundance of each algal genus (and of all diatom genera collectively) was estimated for comparative purposes, according to the following system:

- rare (R): fewer than 1 cell per field of view at 200X, on the average;
- common (C): at least 1 but fewer than 5 cells per field of view;
- very common (VC): between 5 and 25 cells per field of view;
- abundant (A): more than 25 cells per field of view, but countable;
- very abundant (VA): number of cells per field of view too numerous to count.

Soft-bodied genera (and the diatom component) were also ranked according to their estimated contribution to the total algal biovolume present in the sample. The genus with the most biomass ranked number 1; the genus with the next most biomass ranked number 2, and so on.

Data analysis

Diatom data, including species names and counts, and non-diatom algae data, including generic names, relative abundances and biovolume rankings, were entered into Rhithron's customized laboratory information management system. A formatted data file for upload to the MT-eWQX database was generated for the diatom samples. Metric calculations, consistent with Montana Department of Environmental Quality (MDEQ 2011) data requirements, were performed for diatom samples. An Excel file including taxon names, relative abundances and biovolume rankings was created for the non-diatom algae samples.

RESULTS

Data analysis

Electronic spreadsheets were provided to the Montana Biological Survey Project Manager via e-mail. Taxa lists are provided in an Appendix to this report.

REFERENCES

ANSP. 2002. Protocols for the analysis of algal samples collected as part of the U.S. Geological Survey National Water-Quality Assessment Program. The Academy of Natural Sciences Patrick Center for Environmental Research: Report No. 02-06. May 2002.

MDEQ. 2011. Periphyton Standard Operating Procedure. Montana Department of Environmental Quality. Water Quality Planning Bureau. Standard Operating Procedure. WQPBWQM-010. Helena, Montana.

APPENDIX

Diatom Taxa Lists
Non-diatom Algae Results

Black Butte Mine 2019

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM001

RAI No.: MM19BBM001 Sta. Name: Sheep Creek #1
Client ID: AQ1
Date Coll.: 7/30/2019 No Jars: 1 STORET ID:
Sample Notes: 5667 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Diatoms				
Bacillariophyta				
Achnanthidium crassum	2	0.25%		
Achnanthidium minutissimum	63	7.88%		
Achnanthidium pyrenaicum	2	0.25%		
Adlafia bryophila	7	0.88%		
Adlafia minuscula	1	0.13%		
Amphipleura pellucida	14	1.75%		
Amphora minutissima	1	0.13%		
Amphora ovalis	1	0.13%		
Amphora pediculus	58	7.25%		
Cocconeis pediculus	10	1.25%		
Cocconeis placentula sensu lato	31	3.88%		
Craticula subminuscula	1	0.13%		
Cyclotella meneghiniana	1	0.13%		
Cymbella affinis	12	1.50%		small
Cymbella compacta	9	1.13%		big
Diatoma moniliformis	82	10.25%		
Diploneis oblongella	3	0.38%		
Encyonema minutum	8	1.00%		
Encyonema reichardtii	2	0.25%		
Encyonema silesiacum	23	2.88%		
Encyonopsis minuta	8	1.00%		
Epithemia sorex	1	0.13%		
Fallacia lenzii	3	0.38%		
Fragilaria capucina	4	0.50%		
Frustulia vulgaris	1	0.13%		
Geissleria acceptata	1	0.13%		
Gomphonella olivacea	40	5.00%		
Gomphonema sp.	1	0.13%		GV
Gomphonema kobayasii	4	0.50%		
Gomphonema minusculum	6	0.75%		
Gomphonema minutum	15	1.88%		
Gomphonema parvulum	3	0.38%		
Gyrosigma attenuatum	1	0.13%		
Mayamaea atomus	4	0.50%		
Navicula sp.	2	0.25%		broken/GV
Navicula antonii	2	0.25%		
Navicula capitatoradiata	8	1.00%		
Navicula caterva	43	5.38%		
Navicula cryptotenella	21	2.63%		
Navicula tripunctata	32	4.00%		
Nitzschia sp.	4	0.50%		pura/lin

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM001

RAI No.: MM19BBM001 Sta. Name: Sheep Creek #1
Client ID: AQ1
Date Coll.: 7/30/2019 No Jars: 1 STORET ID:
Sample Notes: 5667 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Nitzschia sp.	7	0.88%		GV with darl fibulae
Nitzschia acicularis	8	1.00%		
Nitzschia archibaldii	36	4.50%		
Nitzschia dissipata	17	2.13%		
Nitzschia linearis	2	0.25%		
Nitzschia palea	18	2.25%		
Nitzschia paleacea	4	0.50%		
Nitzschia pura	3	0.38%		
Nitzschia sociabilis	32	4.00%		
Nitzschia subtilis	8	1.00%		
Odontidium mesodon	4	0.50%		
Planothidium dubium	8	1.00%		
Planothidium frequentissimum	8	1.00%		
Planothidium lanceolatum	16	2.00%		
Reimeria sinuata	3	0.38%		
Sellaphora sp.	2	0.25%		GV
Sellaphora atomoides	3	0.38%		
Sellaphora nigri	11	1.38%		
Sellaphora seminulum	1	0.13%		
Staurosira construens v. venter	39	4.88%		
Staurosirella sp.	5	0.63%		
Staurosirella leptostauron	17	2.13%		
Staurosirella leptostauron v. dubia	1	0.13%		
Surirella amphioxys	1	0.13%		
Surirella angustata	1	0.13%		
Surirella brebissonii	5	0.63%		
Tryblionella hungarica	1	0.13%		
Ulnaria sp.	4	0.50%		broken
Sample Count	800			

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM002

RAI No.: MM19BBM002 Sta. Name: Sheep Creek #2
Client ID: AQ2
Date Coll.: 7/29/2019 No Jars: 1 STORET ID:
Sample Notes: 5821 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Diatoms				
Bacillariophyta				
Achnanthidium sp.	2	0.25%		obscure
Achnanthidium minutissimum	114	14.25%		
Achnanthidium pyrenaicum	5	0.63%		
Adlafia bryophila	9	1.13%		
Amphipleura pellucida	3	0.38%		
Amphora pediculus	125	15.63%		
Caloneis sp.	1	0.13%		GV
Cocconeis pediculus	4	0.50%		
Cocconeis placentula sensu lato	39	4.88%		
Cyclotella meneghiniana	1	0.13%		
Cymbella affinis	27	3.38%		
Cymbella compacta	2	0.25%		big
Diatoma moniliformis	166	20.75%		
Diatoma vulgaris	2	0.25%		
Diploneis oblongella	2	0.25%		
Encyonema minutum	11	1.38%		
Encyonema reichardtii	14	1.75%		
Encyonema silesiacum	31	3.88%		
Encyonopsis minuta	17	2.13%		10 GV
Encyonopsis subminuta	2	0.25%		
Epithemia sorex	11	1.38%		
Fallacia lenzii	2	0.25%		
Fragilaria sp.	1	0.13%		
Gomphonella olivacea	7	0.88%		
Gomphonema sp.	10	1.25%		GV no pores
Gomphonema kobayasii	4	0.50%		
Gomphonema minutum	2	0.25%		
Gyrosigma attenuatum	3	0.38%		
Mayamaea fossalis	1	0.13%		
Mayamaea permitis	1	0.13%		
Meridion circulare	2	0.25%		
Navicula sp.	6	0.75%		GV
Navicula antonii	1	0.13%		
Navicula caterva	15	1.88%		
Navicula cryptotenella	38	4.75%		
Navicula cryptotenelloides	1	0.13%		
Navicula tripunctata	22	2.75%		
Nitzschia sp.	3	0.38%		GV/broken
Nitzschia archibaldii	15	1.88%		
Nitzschia dissipata	14	1.75%		
Nitzschia frustulum	3	0.38%		with striae

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM002

RAI No.: MM19BBM002 Sta. Name: Sheep Creek #2
Client ID: AQ2
Date Coll.: 7/29/2019 No Jars: 1 STORET ID:
Sample Notes: 5821 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Nitzschia linearis	1	0.13%		
Nitzschia palea	8	1.00%		
Nitzschia sociabilis	2	0.25%		
Nitzschia sublinearis	2	0.25%		
Planothidium frequentissimum	4	0.50%		
Reimeria sinuata	4	0.50%		
Reimeria uniseriata	2	0.25%		
Rhopalodia gibba	4	0.50%		
Sellaphora sp.	4	0.50%		GV
Sellaphora atomoides	1	0.13%		
Sellaphora nigri	2	0.25%		
Staurosira construens v. venter	19	2.38%		
Staurosirella leptostauron	2	0.25%		
Staurosirella pinnata	2	0.25%		
Surirella angusta	1	0.13%		
Ulnaria sp.	3	0.38%		broken

Sample Count 800

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM003

RAI No.: MM19BBM003 Sta. Name: Sheep Creek #3
Client ID: AQ3
Date Coll.: 7/30/2019 No Jars: 1 STORET ID:
Sample Notes: 5739 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Diatoms				
Bacillariophyta				
Achnanthidium minutissimum	103	12.88%		
Achnanthidium pyrenaicum	1	0.13%		
Adlafia minuscula	1	0.13%		
Amphipleura pellucida	9	1.13%		
Amphora copulata	2	0.25%		
Amphora pediculus	29	3.63%		
Caloneis bacillum	1	0.13%		
Chamaepinnularia sp.	1	0.13%		obscure
Cocconeis pediculus	8	1.00%		
Cocconeis placentula sensu lato	91	11.38%		
Cyclotella meneghiniana	4	0.50%		
Cymbella affinis	5	0.63%		
Diatoma moniliformis	93	11.63%		
Diatoma vulgaris	1	0.13%		
Diploneis oblongella	1	0.13%		
Encyonema reichardtii	3	0.38%		small
Encyonema silesiacum	21	2.63%		6GV
Encyonopsis minuta	7	0.88%		
Epithemia turgida	1	0.13%		
Fallacia lenzii	3	0.38%		
Fragilaria vaucheriae	2	0.25%		
Geissleria acceptata	2	0.25%		
Gomphonema sp.	5	0.63%		GV
Gomphonema kobayasii	11	1.38%		
Gomphonema minutum	7	0.88%		
Gomphonema parvulum	2	0.25%		
Gomphonema rhombicum	2	0.25%		
Gomphosinica sp.	2	0.25%		
Gyrosigma attenuatum	1	0.13%		
Hannaea sp.	1	0.13%		broken
Meridion circulare	41	5.13%		
Navicula sp.	1	0.13%		unsymmetric centre
Navicula capitatoradiata	2	0.25%		
Navicula caterva	26	3.25%		4 GV
Navicula cryptotenella	13	1.63%		
Navicula tripunctata	13	1.63%		
Navicula trivialis	1	0.13%		
Nitzschia sp.	6	0.75%		GV
Nitzschia archibaldii	52	6.50%		
Nitzschia dissipata	11	1.38%		
Nitzschia frustulum	2	0.25%		striae

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM003

RAI No.: MM19BBM003 Sta. Name: Sheep Creek #3
Client ID: AQ3
Date Coll.: 7/30/2019 No Jars: 1 STORET ID:
Sample Notes: 5739 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Nitzschia graciliformis	2	0.25%		
Nitzschia linearis	11	1.38%		
Nitzschia palea	39	4.88%		
Nitzschia sociabilis	4	0.50%		
Nitzschia tenuis	3	0.38%		
Odontidium mesodon	11	1.38%		
Planothidium dubium	12	1.50%		
Planothidium frequentissimum	8	1.00%		
Planothidium lanceolatum	8	1.00%		
Planothidium rostratum	2	0.25%		
Reimeria sinuata	2	0.25%		
Sellaphora nigri	7	0.88%		
Sellaphora pupula	2	0.25%		
Staurosira construens v. venter	42	5.25%		
Staurosirella sp.	1	0.13%		
Staurosirella leptostauron	52	6.50%		
Staurosirella pinnata	1	0.13%		
Surirella angusta	1	0.13%		
Surirella brebissonii	3	0.38%		
Ulnaria sp.	1	0.13%		

Sample Count 800

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM004

RAI No.: MM19BBM004 Sta. Name: Sheep Creek #4
Client ID: AQ4
Date Coll.: 7/29/2019 No Jars: 1 STORET ID:
Sample Notes: 5703 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Diatoms				
Bacillariophyta				
Achnanthidium minutissimum	64	7.99%		
Adlafia minuscula	3	0.37%		
Amphipleura pellucida	11	1.37%		
Amphora ovalis	2	0.25%		
Amphora pediculus	41	5.12%		
Caloneis sp.	1	0.12%		
Cocconeis pediculus	5	0.62%		
Cocconeis placentula sensu lato	30	3.75%		
Cyclotella meneghiniana	1	0.12%		
Cymbella affiniformis	3	0.37%		
Cymbella affinis	38	4.74%		
Cymbella compacta	15	1.87%		big
Diatoma moniliformis	84	10.49%		
Encyonema minutum	7	0.87%		
Encyonema procerum	1	0.12%		
Encyonema reichardtii	1	0.12%		
Encyonema silesiacum	21	2.62%		
Encyonopsis krammeri	1	0.12%		
Eucocconeis flexella	1	0.12%		
Eunotia minor	4	0.50%		3 GV
Fistulifera pelliculosa	1	0.12%		
Fragilaria sp.	1	0.12%		obscure view
Frustulia rexii	2	0.25%		
Geissleria sp.	1	0.12%		
Gomphonella olivacea	28	3.50%		
Gomphonema sp.	22	2.75%		GV
Gomphonema minutum	14	1.75%		
Gomphonema pumilum v. rigidum	5	0.62%		small linear
Gyrosigma attenuatum	2	0.25%		
Mayamaea permitis	1	0.12%		
Meridion circulare	2	0.25%		
Navicula sp.	1	0.12%		GV
Navicula antonii	2	0.25%		
Navicula capitatoradiata	15	1.87%		
Navicula caterva	44	5.49%		
Navicula cryptotenella	32	4.00%		
Navicula cryptotenelloides	2	0.25%		
Navicula gregaria	3	0.37%		
Navicula radiosa	1	0.12%		
Navicula tripunctata	43	5.37%		
Nitzschia sp.	11	1.37%		GV/broken

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM004

RAI No.: MM19BBM004 Sta. Name: Sheep Creek #4
Client ID: AQ4
Date Coll.: 7/29/2019 No Jars: 1 STORET ID:
Sample Notes: 5703 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Nitzschia acicularis	1	0.12%		
Nitzschia acidoclinata	1	0.12%		
Nitzschia archibaldii	40	4.99%		
Nitzschia dissipata	31	3.87%		
Nitzschia gracilis	1	0.12%		
Nitzschia linearis	11	1.37%		
Nitzschia palea	21	2.62%		
Nitzschia paleacea	2	0.25%		
Nitzschia tenuis	6	0.75%		
Odontidium mesodon	3	0.37%		
Planothidium dubium	5	0.62%		
Planothidium frequentissimum	16	2.00%		
Planothidium lanceolatum	12	1.50%		
Reimeria sinuata	14	1.75%		
Rhoicosphenia sp.	1	0.12%		GV
Sellaphora nigri	4	0.50%		
Sellaphora pupula	3	0.37%		
Staurosira construens v. venter	29	3.62%		6 big
Staurosirella sp.	4	0.50%		
Staurosirella leptostauron	15	1.87%		
Surirella angusta	1	0.12%		
Surirella brebissonii	9	1.12%		
Ulnaria ulna	4	0.50%		

Sample Count 801

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM005

RAI No.: MM19BBM005 | Sta. Name: Tenderfoot Creek #5
Client ID: AQ5
Date Coll.: 7/29/2019 | No Jars: 1 | STORET ID:
Sample Notes: 4793 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Diatoms				
Bacillariophyta				
Achnanthidium minutissimum	63	7.88%		
Adlafia minuscula	3	0.38%		
Amphipleura pellucida	7	0.88%		
Cocconeis placentula sensu lato	107	13.38%		
Cymbella affinis	2	0.25%		
Diatoma moniliformis	154	19.25%		
Encyonema minutum	66	8.25%		
Encyonema silesiacum	5	0.63%		
Entomoneis sp.	1	0.13%		broken
Epithemia sorex	10	1.25%		
Eunotia sp.	1	0.13%		broken
Fragilaria sp.	3	0.38%		GV
Fragilaria capucina v. gracilis	1	0.13%		
Fragilaria microvaucheriae	1	0.13%		
Fragilaria pectinalis	12	1.50%		long
Geissleria sp.	1	0.13%		
Gomphoneis eriense	13	1.63%		big
Gomphonema sp.	7	0.88%		2 long GV
Gomphonema angustum	2	0.25%		
Gomphonema incognitum	1	0.13%		
Gomphonema minutum	6	0.75%		
Gomphonema olivaceoides v. densestriata	1	0.13%		
Gomphonema pumilum v. rigidum	3	0.38%		
Gomphosphenia praegnans	4	0.50%		
Karayevia clevei	1	0.13%		
Karayevia laterostrata	2	0.25%		
Mayamaea permitis	7	0.88%		
Meridion circulare	4	0.50%		
Navicula antonii	1	0.13%		
Navicula capitatoradiata	12	1.50%		
Navicula caterva	22	2.75%		
Navicula cryptotenella	14	1.75%		
Navicula radiosa	1	0.13%		
Navicula tripunctata	4	0.50%		
Nitzschia sp.	17	2.13%		GV
Nitzschia acicularis	1	0.13%		
Nitzschia archibaldii	100	12.50%		
Nitzschia dissipata	8	1.00%		
Nitzschia fonticoloides	13	1.63%		
Nitzschia frustulum	10	1.25%		
Nitzschia innominata	2	0.25%		

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM005

RAI No.: MM19BBM005 Sta. Name: Tenderfoot Creek #5
Client ID: AQ5
Date Coll.: 7/29/2019 No Jars: 1 STORET ID:
Sample Notes: 4793 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Nitzschia linearis	2	0.25%		
Nitzschia oregona	2	0.25%		
Nitzschia palea	1	0.13%		
Nitzschia paleacea	2	0.25%		
Nitzschia soratensis	3	0.38%		
Planothidium dubium	2	0.25%		
Planothidium frequentissimum	18	2.25%		
Planothidium lanceolatum	8	1.00%		
Reimeria sinuata	4	0.50%		
Rhoicosphenia californica	6	0.75%		
Sellaphora nigri	18	2.25%		
Staurosira construens v. venter	7	0.88%		
Staurosirella leptostauron	1	0.13%		
Synedra mazamaensis	1	0.13%		
Ulnaria contracta	1	0.13%		
Ulnaria ulna	30	3.75%		
Undetermined Pennate	1	0.13%		small stright GV
Sample Count	800			

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM006

RAI No.: MM19BBM006 Sta. Name: Tenderfoot Creek #6
Client ID: AQ6
Date Coll.: 7/29/2019 No Jars: 1 STORET ID:
Sample Notes: 4803 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Diatoms				
Bacillariophyta				
Achnanthidium exiguum	1	0.13%		
Achnanthidium minutissimum	57	7.13%		
Adlafia minuscula	7	0.88%		
Amphipleura pellucida	2	0.25%		
Amphora pediculus	8	1.00%		
Cocconeis pediculus	1	0.13%		
Cocconeis placentula sensu lato	99	12.38%		
Diatoma moniliformis	120	15.00%		
Encyonema minutum	65	8.13%		
Encyonema reichardtii	1	0.13%		
Encyonema silesiacum	6	0.75%		
Epithemia sp.	2	0.25%		obscure view
Epithemia sorex	3	0.38%		
Fragilaria sp.	3	0.38%		GV
Fragilaria capucina v. gracilis	2	0.25%		
Fragilaria pectinalis	14	1.75%		
Gomphoneis eriense	10	1.25%		
Gomphonella olivacea	3	0.38%		
Gomphonema sp.	3	0.38%		GV
Gomphonema angustum	1	0.13%		
Gomphonema incognitum	1	0.13%		
Gomphonema minutum	3	0.38%		big
Gomphonema pumilum v. rigidum	1	0.13%		
Gomphosphenia praegnans	2	0.25%		
Mayamaea permitis	8	1.00%		
Meridion circulare	4	0.50%		
Navicula antonii	2	0.25%		
Navicula capitatoradiata	10	1.25%		
Navicula caterva	50	6.25%		
Navicula cryptocephala	5	0.63%		
Navicula cryptotenella	11	1.38%		
Navicula radiosa	1	0.13%		
Navicula tripunctata	1	0.13%		
Nitzschia sp.	3	0.38%		GV
Nitzschia archibaldii	144	18.00%		
Nitzschia dissipata	14	1.75%		
Nitzschia fonticoloides	14	1.75%		
Nitzschia innominata	2	0.25%		
Nitzschia oregona	26	3.25%		
Nitzschia palea	3	0.38%		
Nitzschia sociabilis	1	0.13%		

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM006

RAI No.: MM19BBM006 Sta. Name: Tenderfoot Creek #6
Client ID: AQ6
Date Coll.: 7/29/2019 No Jars: 1 STORET ID:
Sample Notes: 4803 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Nitzschia soratensis	1	0.13%		
Odontidium mesodon	1	0.13%		
Planothidium dubium	4	0.50%		
Planothidium frequentissimum	15	1.88%		
Planothidium lanceolatum	17	2.13%		
Reimeria sinuata	1	0.13%		
Rhoicosphenia californica	3	0.38%		
Sellaphora nigri	6	0.75%		
Staurosira construens v. venter	10	1.25%		
Synedra mazamaensis	2	0.25%		
Ulnaria contracta	3	0.38%		
Ulnaria ulna	23	2.88%		

Sample Count 800

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM007

RAI No.: MM19BBM007 Sta. Name: Little Sheep Creek #7
Client ID: AQ7
Date Coll.: 7/30/2019 No Jars: 1 STORET ID:
Sample Notes: 5738 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Diatoms				
Bacillariophyta				
Achnanthidium minutissimum	176	22.00%		
Amphora pediculus	9	1.13%		
Cocconeis pediculus	4	0.50%		
Cocconeis placentula sensu lato	41	5.13%		
Cymbella affinis	4	0.50%		
Cymbella blinnii	1	0.13%		
Diatoma moniliformis	9	1.13%		
Encyonema sp.	4	0.50%		GV
Encyonema appalachianum	2	0.25%		
Encyonema minutum	2	0.25%		
Encyonema reichardtii	1	0.13%		
Encyonema silesiacum	4	0.50%		
Encyonopsis subminuta	2	0.25%		
Epithemia sp.	1	0.13%		
Fragilaria sp.	5	0.63%		GV
Fragilaria capucina v. gracilis	22	2.75%		
Fragilaria tenera	25	3.13%		big
Fragilaria vaucheriae	7	0.88%		
Geissleria sp.	1	0.13%		
Gomphonema sp.	8	1.00%		GV
Gomphonema angustum	1	0.13%		
Gomphonema minutum	3	0.38%		
Gomphonema parvulum	3	0.38%		
Gomphonema truncatum	1	0.13%		broken
Gomphosphenia praegnans	1	0.13%		
Meridion circulare	24	3.00%		
Navicula sp.	4	0.50%		GV
Navicula caterva	4	0.50%		
Navicula cryptocephala	3	0.38%		
Navicula cryptotenella	6	0.75%		
Navicula gregaria	1	0.13%		
Navicula trivialis	1	0.13%		
Nitzschia sp.	4	0.50%		GV
Nitzschia acicularis	4	0.50%		
Nitzschia archibaldii	19	2.38%		
Nitzschia dissipata	12	1.50%		
Nitzschia linearis	15	1.88%		
Nitzschia oregona	5	0.63%		
Nitzschia palea	10	1.25%		
Nitzschia subtilis	1	0.13%		
Nupela lapidosa	2	0.25%		

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM007

RAI No.: MM19BBM007 Sta. Name: Little Sheep Creek #7
Client ID: AQ7
Date Coll.: 7/30/2019 No Jars: 1 STORET ID:
Sample Notes: 5738 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Odontidium mesodon	3	0.38%		
Planothidium dubium	1	0.13%		
Planothidium frequentissimum	4	0.50%		
Planothidium lanceolatum	2	0.25%		
Reimeria sinuata	2	0.25%		
Sellaphora sp.	1	0.13%		GV
Sellaphora nigri	2	0.25%		
Staurosira construens v. venter	132	16.50%		
Staurosirella sp.	3	0.38%		
Staurosirella leptostauron	58	7.25%		
Staurosirella pinnata	124	15.50%		
Surirella brebissonii	2	0.25%		
Ulnaria ulna	14	1.75%		
Sample Count	800			

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM008

RAI No.: MM19BBM008 Sta. Name: Little Sheep Creek #8
Client ID: AQ8
Date Coll.: 7/30/2019 No Jars: 1 STORET ID:
Sample Notes: 5772 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Diatoms				
Bacillariophyta				
Achnanthidium minutissimum	14	1.75%		
Adlafia minuscula	13	1.63%		
Amphipleura pellucida	3	0.38%		
Caloneis bacillum	2	0.25%		
Chamaepinnularia submuscicola	4	0.50%		
Cocconeis pediculus	19	2.38%		
Cocconeis placentula sensu lato	260	32.50%		
Craticula subminuscula	3	0.38%		
Cyclotella meneghiniana	11	1.38%		
Diatoma moniliformis	3	0.38%		
Diploneis oblongella	10	1.25%		
Encyonema appalachianum	2	0.25%		
Encyonema minutum	6	0.75%		
Encyonema reichardtii	2	0.25%		
Eunotia sp.	6	0.75%		GV
Fallacia sp.	1	0.13%		
Fragilaria sp.	2	0.25%		GV
Fragilaria capucina v. gracilis	54	6.75%		
Fragilaria pectinalis	16	2.00%		small fat
Fragilaria rinoi	3	0.38%		micro
Fragilaria tenera	1	0.13%		
Gomphoneis eriense	1	0.13%		
Gomphonema sp.	10	1.25%		GV
Gomphonema angustum	1	0.13%		
Gomphonema parvulum	1	0.13%		
Mayamaea permitis	12	1.50%		
Meridion circulare	7	0.88%		
Navicula sp.	1	0.13%		small
Navicula capitatoradiata	10	1.25%		
Navicula caterva	12	1.50%		
Navicula cryptocephala	16	2.00%		
Navicula recens	3	0.38%		
Navicula trivialis	1	0.13%		
Nitzschia sp.	12	1.50%		broken/GV
Nitzschia acicularis	22	2.75%		
Nitzschia archibaldii	102	12.75%		
Nitzschia dissipata	17	2.13%		
Nitzschia linearis	4	0.50%		
Nitzschia oregona	8	1.00%		
Nitzschia palea	10	1.25%		
Nitzschia paleacea	3	0.38%		

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM008

RAI No.: MM19BBM008 Sta. Name: Little Sheep Creek #8
Client ID: AQ8
Date Coll.: 7/30/2019 No Jars: 1 STORET ID:
Sample Notes: 5772 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Nitzschia perminuta	1	0.13%		
Nitzschia recta	1	0.13%		
Nitzschia subtilis	5	0.63%		
Nupela sp.	1	0.13%		
Planothidium dubium	6	0.75%		
Planothidium frequentissimum	10	1.25%		
Planothidium lanceolatum	2	0.25%		
Reimeria sinuata	1	0.13%		
Rhoicosphenia sp.	2	0.25%		
Rhopalodia gibba	3	0.38%		
Sellaphora sp.	21	2.63%		cf. elorantana
Sellaphora nigri	26	3.25%		
Sellaphora pupula	2	0.25%		
Staurosira construens v. venter	9	1.13%		
Staurosirella leptostauron	3	0.38%		
Surirella sp.	1	0.13%		broken
Surirella angusta	4	0.50%		
Ulnaria ulna	14	1.75%		

Sample Count 800

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM009

RAI No.: MM19BBM009 Sta. Name: Coon Creek #9
Client ID: AQ9
Date Coll.: 7/30/2019 No Jars: 1 STORET ID:
Sample Notes: 5705 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Diatoms				
Bacillariophyta				
Achnanthidium minutissimum	176	22.00%		
Adlafia minuscula	2	0.25%		
Amphipleura pellucida	2	0.25%		
Amphora pediculus	65	8.13%		
Caloneis bacillum	2	0.25%		
Cocconeis pediculus	1	0.13%		
Cocconeis placentula sensu lato	107	13.38%		
Craticula sp.	1	0.13%		
Cymatopleura sp.	3	0.38%		higher striae
Cymbella sp.	1	0.13%		obscure view
Diatoma moniliformis	2	0.25%		
Diploneis oblongella	3	0.38%		
Encyonema sp.	3	0.38%		GV
Encyonema minutum	2	0.25%		
Eunotia sp.	1	0.13%		
Gomphonema sp.	3	0.38%		high striae
Gomphonema micropus	19	2.38%		
Humidophila sp.	1	0.13%		
Mayamaea permitis	5	0.63%		
Meridion circulare	98	12.25%		
Navicula aitchelbee	1	0.13%		
Navicula capitatoradiata	7	0.88%		
Navicula caterva	19	2.38%		
Navicula cryptocephala	2	0.25%		
Navicula gregaria	2	0.25%		
Navicula radiosa	1	0.13%		
Navicula tripunctata	6	0.75%		
Nitzschia sp.	7	0.88%		GV
Nitzschia acicularis	1	0.13%		
Nitzschia archibaldii	14	1.75%		
Nitzschia dissipata	20	2.50%		
Nitzschia linearis	14	1.75%		
Nitzschia oregona	7	0.88%		
Nitzschia palea	14	1.75%		
Nitzschia subtilis	1	0.13%		
Odontidium mesodon	3	0.38%		
Planothidium dubium	8	1.00%		
Planothidium frequentissimum	30	3.75%		
Planothidium lanceolatum	24	3.00%		
Reimeria sinuata	5	0.63%		
Rhoicosphenia californica	12	1.50%		

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM009

RAI No.: MM19BBM009 | Sta. Name: Coon Creek #9
Client ID: AQ9
Date Coll.: 7/30/2019 | No Jars: 1 | STORET ID:
Sample Notes: 5705 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Sellaphora sp.	4	0.50%		GV
Sellaphora atomoides	3	0.38%		
Sellaphora nigri	18	2.25%		
Staurosirella sp.	45	5.63%		erent sizez and shapes, resembles fragilaria but lack empty sp
Surirella angusta	2	0.25%		
Ulnaria ulna	33	4.13%		

Sample Count 800

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM010

RAI No.: MM19BBM010 Sta. Name: Sheep Creek #10
Client ID: AQ10
Date Coll.: 7/30/2019 No Jars: 1 STORET ID:
Sample Notes: 5420 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Diatoms				
Bacillariophyta				
Achnanthidium minutissimum	235	29.38%		
Amphipleura pellucida	6	0.75%		
Amphora pediculus	13	1.63%		
Caloneis sp.	2	0.25%		GV
Cocconeis pediculus	113	14.13%		
Cocconeis placentula sensu lato	38	4.75%		
Cymatopleura solea	1	0.13%		
Cymbella affinis	11	1.38%		
Cymbella compacta	3	0.38%		big
Diatoma moniliformis	65	8.13%		
Encyonema sp.	3	0.38%		GV
Encyonema minutum	12	1.50%		
Encyonema reichardtii	1	0.13%		
Encyonema silesiacum	8	1.00%		
Encyonopsis perborealis	2	0.25%		
Epithemia sp.	3	0.38%		big GV
Epithemia sorex	8	1.00%		
Eucocconeis laevis	1	0.13%		
Fragilaria sp.	2	0.25%		GV
Fragilaria capucina v. gracilis	3	0.38%		
Gomphonella olivacea	14	1.75%		
Gomphonema sp.	23	2.88%		small GV and 5 long GV
Gomphonema clavatum	1	0.13%		
Gomphonema minutum	11	1.38%		
Gomphonema pumilum v. rigidum	13	1.63%		
Mayamaea permitis	5	0.63%		
Meridion circulare	1	0.13%		
Navicula capitatoradiata	9	1.13%		
Navicula caterva	30	3.75%		
Navicula cryptotenella	15	1.88%		
Navicula cryptotenelloides	1	0.13%		
Navicula tripunctata	13	1.63%		
Nitzschia sp.	9	1.13%		GV
Nitzschia acicularis	2	0.25%		
Nitzschia archibaldii	23	2.88%		
Nitzschia dissipata	6	0.75%		
Nitzschia linearis	2	0.25%		
Nitzschia oregona	5	0.63%		
Nitzschia palea	14	1.75%		
Nitzschia subtilis	2	0.25%		
Odontidium mesodon	1	0.13%		

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM010

RAI No.: MM19BBM010 Sta. Name: Sheep Creek #10
Client ID: AQ10
Date Coll.: 7/30/2019 No Jars: 1 STORET ID:
Sample Notes: 5420 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Planothidium dubium	2	0.25%		
Planothidium frequentissimum	17	2.13%		
Planothidium lanceolatum	3	0.38%		
Pseudostaurosira parasitica	1	0.13%		
Reimeria sinuata	2	0.25%		
Rhoicosphenia californica	3	0.38%		
Sellaphora nigri	6	0.75%		
Staurosira construens v. venter	17	2.13%		
Staurosirella sp.	2	0.25%		
Staurosirella leptostauron	9	1.13%		
Staurosirella pinnata	4	0.50%		
Surirella angustata	1	0.13%		
Ulnaria ulna	3	0.38%		

Sample Count 800

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM011

RAI No.: MM19BBM011 Sta. Name: Sheep Creek #11
Client ID: AQ11
Date Coll.: 7/29/2019 No Jars: 1 STORET ID:
Sample Notes: 5350 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Diatoms				
Bacillariophyta				
Achnanthidium sp.	2	0.25%		
Achnanthidium minutissimum	91	11.38%		
Adlafia bryophila	2	0.25%		
Adlafia minuscula	2	0.25%		
Amphipleura pellucida	10	1.25%		
Amphora pediculus	24	3.00%		
Caloneis bacillum	4	0.50%		GV
Cocconeis pediculus	7	0.88%		
Cocconeis placentula sensu lato	37	4.63%		
Cymbella affinis	13	1.63%		
Cymbella compacta	2	0.25%		
Diatoma moniliformis	88	11.00%		
Encyonema minutum	22	2.75%		
Encyonema reichardtii	1	0.13%		
Encyonema silesiacum	21	2.63%		
Encyonopsis minuta	3	0.38%		
Epithemia sp.	1	0.13%		GV
Epithemia sorex	24	3.00%		
Fallacia lenzii	1	0.13%		
Fragilaria sp.	2	0.25%		GV
Fragilaria capucina v. gracilis	3	0.38%		
Fragilaria pectinalis	5	0.63%		
Geissleria sp.	1	0.13%		
Gomphonella olivacea	16	2.00%		
Gomphonema sp.	6	0.75%		GV
Gomphonema angustum	1	0.13%		
Gomphonema clavatum	1	0.13%		
Gomphonema minutum	6	0.75%		
Gomphonema pumilum v. rigidum	4	0.50%		
Gyrosigma sp.	1	0.13%		
Mayamaea permitis	5	0.63%		
Meridion circulare	1	0.13%		
Navicula antonii	3	0.38%		
Navicula capitatoradiata	12	1.50%		
Navicula caterva	39	4.88%		
Navicula cryptotenella	38	4.75%		
Navicula cryptotenelloides	8	1.00%		
Navicula lundii	1	0.13%		
Navicula radiosa	2	0.25%		
Navicula tripunctata	51	6.38%		
Nitzschia sp.	6	0.75%		GV

Taxa Listing

Project ID: MM19BBM
RAI No.: MM19BBM011

RAI No.: MM19BBM011 Sta. Name: Sheep Creek #11
Client ID: AQ11
Date Coll.: 7/29/2019 No Jars: 1 STORET ID:
Sample Notes: 5350 ft

Taxonomic Name	Count	PRA	Cell Count	Comment
Nitzschia archibaldii	34	4.25%		
Nitzschia dissipata	15	1.88%		
Nitzschia linearis	8	1.00%		
Nitzschia oregona	15	1.88%		
Nitzschia palea	23	2.88%		
Nitzschia sociabilis	2	0.25%		
Nitzschia soratensis	1	0.13%		
Nitzschia subtilis	1	0.13%		
Odontidium mesodon	5	0.63%		
Planothidium dubium	5	0.63%		
Planothidium frequentissimum	21	2.63%		
Planothidium lanceolatum	7	0.88%		
Reimeria sinuata	6	0.75%		
Rhoicosphenia californica	5	0.63%		
Rossithidium pusillum	1	0.13%		
Sellaphora bacillum	1	0.13%		
Sellaphora nigri	13	1.63%		
Staurosira construens v. venter	40	5.00%		
Staurosirella sp.	1	0.13%		
Staurosirella leptostauron	15	1.88%		
Staurosirella pinnata	5	0.63%		
Surirella angusta	1	0.13%		
Surirella brebissonii	6	0.75%		
Ulnaria ulna	2	0.25%		

Sample Count 800

Non-diatom algae study: Black Butte Mine 2019 **Non-Diatom Algae Data**					**Determinations by** **Rhithron Associates, Inc.**		
RAI Sample ID	**Client ID**	**Station Name**	**Sample Date**	**Taxon**	**Division**	**Relative Abundance**	**Biovolume Rank**
MM19BBM001	AQ1	Sheep Creek #1	7/30/2019	Diatoms	Bacillariophyta	A	1
MM19BBM001	AQ1	Sheep Creek #1	7/30/2019	*Calothrix*	Cyanophyta	C	2
MM19BBM001	AQ1	Sheep Creek #1	7/30/2019	*Leptolyngbya*	Cyanophyta	C	3
MM19BBM001	AQ1	Sheep Creek #1	7/30/2019	*Phormidium*	Cyanophyta	R	0
MM19BBM002	AQ2	Sheep Creek #2	7/29/2019	*Cladophora*	Chlorophyta	VC	1
MM19BBM002	AQ2	Sheep Creek #2	7/29/2019	Diatoms	Bacillariophyta	VC	2
MM19BBM002	AQ2	Sheep Creek #2	7/29/2019	*Leptolyngbya*	Cyanophyta	C	3
MM19BBM002	AQ2	Sheep Creek #2	7/29/2019	*Heteroleibleinia*	Cyanophyta	C	4
MM19BBM002	AQ2	Sheep Creek #2	7/29/2019	*Calothrix*	Cyanophyta	R	0
MM19BBM002	AQ2	Sheep Creek #2	7/29/2019	Undetermined Rhodophyte	Rhodophyta	R	0
MM19BBM003	AQ3	Sheep Creek #3	7/30/2019	*Cladophora*	Chlorophyta	VC	1
MM19BBM003	AQ3	Sheep Creek #3	7/30/2019	Diatoms	Bacillariophyta	A	2
MM19BBM003	AQ3	Sheep Creek #3	7/30/2019	*Leptolyngbya*	Cyanophyta	C	3
MM19BBM003	AQ3	Sheep Creek #3	7/30/2019	*Nostoc*	Cyanophyta	R	0
MM19BBM004	AQ4	Sheep Creek #4	7/29/2019	Diatoms	Bacillariophyta	A	1
MM19BBM004	AQ4	Sheep Creek #4	7/29/2019	*Leptolyngbya*	Cyanophyta	C	2
MM19BBM005	AQ5	Tenderfoot Creek #5	7/29/2019	Diatoms	Bacillariophyta	C	1
MM19BBM005	AQ5	Tenderfoot Creek #5	7/29/2019	*Leptolyngbya*	Cyanophyta	C	2
MM19BBM005	AQ5	Tenderfoot Creek #5	7/29/2019	*Homoeothrix*	Cyanophyta	R	0
MM19BBM005	AQ5	Tenderfoot Creek #5	7/29/2019	*Nostoc*	Cyanophyta	R	0
MM19BBM006	AQ6	Tenderfoot Creek #6	7/29/2019	Diatoms	Bacillariophyta	C	1
MM19BBM006	AQ6	Tenderfoot Creek #6	7/29/2019	*Homoeothrix*	Cyanophyta	C	2
MM19BBM006	AQ6	Tenderfoot Creek #6	7/29/2019	*Nostoc*	Cyanophyta	C	3
MM19BBM006	AQ6	Tenderfoot Creek #6	7/29/2019	Undetermined Rhodophyte	Rhodophyta	R	0
MM19BBM007	AQ7	Little Sheep Creek #7	7/30/2019	*Cladophora*	Chlorophyta	VC	1
MM19BBM007	AQ7	Little Sheep Creek #7	7/30/2019	Diatoms	Bacillariophyta	VC	2
MM19BBM007	AQ7	Little Sheep Creek #7	7/30/2019	*Leptolyngbya*	Cyanophyta	C	3
MM19BBM007	AQ7	Little Sheep Creek #7	7/30/2019	*Monoraphidium*	Chlorophyta	R	0
MM19BBM007	AQ7	Little Sheep Creek #7	7/30/2019	*Nostoc*	Cyanophyta	R	0
MM19BBM007	AQ7	Little Sheep Creek #7	7/30/2019	*Phormidium*	Cyanophyta	R	0
MM19BBM008	AQ8	Little Sheep Creek #8	7/30/2019	*Cladophora*	Chlorophyta	A	1
MM19BBM008	AQ8	Little Sheep Creek #8	7/30/2019	Diatoms	Bacillariophyta	VC	2
MM19BBM008	AQ8	Little Sheep Creek #8	7/30/2019	*Leptolyngbya*	Cyanophyta	C	3
MM19BBM008	AQ8	Little Sheep Creek #8	7/30/2019	*Nostoc*	Cyanophyta	R	0
MM19BBM009	AQ9	Coon Creek #9	7/30/2019	Diatoms	Bacillariophyta	VC	1
MM19BBM009	AQ9	Coon Creek #9	7/30/2019	*Leptolyngbya*	Cyanophyta	R	0

Non-diatom algae study: Black Butte Mine 2019 **Non-Diatom Algae Data**					**Determinations by** **Rhithron Associates, Inc.**		
RAI Sample ID	**Client ID**	**Station Name**	**Sample Date**	**Taxon**	**Division**	**Relative Abundance**	**Biovolume Rank**
MM19BBM010	AQ10	Sheep Creek #10	7/30/2019	*Cladophora*	Chlorophyta	A	1
MM19BBM010	AQ10	Sheep Creek #10	7/30/2019	Diatoms	Bacillariophyta	C	2
MM19BBM010	AQ10	Sheep Creek #10	7/30/2019	*Leptolyngbya*	Cyanophyta	C	3
MM19BBM010	AQ10	Sheep Creek #10	7/30/2019	*Heteroleibleinia*	Cyanophyta	VC	4
MM19BBM010	AQ10	Sheep Creek #10	7/30/2019	*Chroococcus*	Cyanophyta	R	0
MM19BBM011	AQ11	Sheep Creek #11	7/29/2019	Diatoms	Bacillariophyta	C	1
MM19BBM011	AQ11	Sheep Creek #11	7/29/2019	*Homoeothrix*	Cyanophyta	C	2
MM19BBM011	AQ11	Sheep Creek #11	7/29/2019	*Calothrix*	Cyanophyta	R	0
MM19BBM011	AQ11	Sheep Creek #11	7/29/2019	Undetermined Cyanophyte	Cyanophyta	R	0
MM19BBM011	AQ11	Sheep Creek #11	7/29/2019	Undetermined Rhodophyte	Rhodophyta	R	0

ANALYTICAL SUMMARY REPORT

September 25, 2019

Stag Benthics
1901 Peosta Ave
Helena, MT 59601-1625

Work Order: H19080446

Project Name: Tintina Resources

Energy Laboratories Inc Helena MT received the following 25 samples for Stag Benthics on 8/13/2019 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H19080446-001	Sheep Creek AQ 1-1	08/13/19 9:00	08/13/19	Biomass	Chlorophyll-A-Biomass Solid Chlorophyll Prep A10200 H
H19080446-002	Sheep Creek AQ1-2	08/13/19 9:00	08/13/19	Biomass	Same As Above
H19080446-003	Sheep Creek AQ1-3	08/13/19 9:00	08/13/19	Biomass	Same As Above
H19080446-004	Sheep Creek AQ1-4	08/13/19 9:00	08/13/19	Biomass	Same As Above
H19080446-005	Sheep Creek AQ1-5	08/13/19 9:00	08/13/19	Biomass	Same As Above
H19080446-006	Sheep Creek AQ2-1	08/13/19 11:00	08/13/19	Biomass	Same As Above
H19080446-007	Sheep Creek AQ2-2	08/13/19 11:00	08/13/19	Biomass	Same As Above
H19080446-008	Sheep Creek AQ2-3	08/13/19 11:00	08/13/19	Biomass	Same As Above
H19080446-009	Sheep Creek AQ2-4	08/13/19 11:00	08/13/19	Biomass	Same As Above
H19080446-010	Sheep Creek AQ2-5	08/13/19 11:00	08/13/19	Biomass	Same As Above
H19080446-011	Sheep Creek AQ3-1	08/13/19 10:30	08/13/19	Biomass	Same As Above
H19080446-012	Sheep Creek AQ3-2	08/13/19 10:30	08/13/19	Biomass	Same As Above
H19080446-013	Sheep Creek AQ3-3	08/13/19 10:30	08/13/19	Biomass	Same As Above
H19080446-014	Sheep Creek AQ3-4	08/13/19 10:30	08/13/19	Biomass	Same As Above
H19080446-015	Sheep Creek AQ3-5	08/13/19 10:30	08/13/19	Biomass	Same As Above
H19080446-016	Sheep Creek AQ4-1	08/13/19 10:00	08/13/19	Biomass	Same As Above
H19080446-017	Sheep Creek AQ4-2	08/13/19 10:00	08/13/19	Biomass	Same As Above
H19080446-018	Sheep Creek AQ4-3	08/13/19 10:00	08/13/19	Biomass	Same As Above
H19080446-019	Sheep Creek AQ4-4	08/13/19 10:00	08/13/19	Biomass	Same As Above
H19080446-020	Sheep Creek AQ4-5	08/13/19 10:00	08/13/19	Biomass	Same As Above
H19080446-021	Sheep Creek AQ10-1	08/13/19 9:30	08/13/19	Biomass	Same As Above
H19080446-022	Sheep Creek AQ10-2	08/13/19 9:30	08/13/19	Biomass	Same As Above
H19080446-023	Sheep Creek AQ10-3	08/13/19 9:30	08/13/19	Biomass	Same As Above
H19080446-024	Sheep Creek AQ10-4	08/13/19 9:30	08/13/19	Biomass	Same As Above
H19080446-025	Sheep Creek AQ10-5	08/13/19 9:30	08/13/19	Biomass	Same As Above

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative. Any issues encountered during sample

ANALYTICAL SUMMARY REPORT

receipt are documented in the Work Order Receipt Checklist.

The results as reported relate only to the item(s) submitted for testing. This report shall be used or copied only in its entirety. Energy Laboratories, Inc. is not responsible for the consequences arising from the use of a partial report.

If you have any questions regarding these test results, please contact your Project Manager.

Report Approved By:

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 09:00
Lab ID:	H19080446-001	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ 1-1	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	161.0	mg/m2		0.1		A10200 H	09/22/19 01:20 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Stag Benthics
Project: Tintina Resources
Lab ID: H19080446-002
Client Sample ID: Sheep Creek AQ1-2

Report Date: 09/25/19
Collection Date: 08/13/19 09:00
DateReceived: 08/13/19
Matrix: Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	113.0	mg/m2		0.1		A10200 H	09/22/19 01:48 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 09:00
Lab ID:	H19080446-003	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ1-3	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	93.9	mg/m2		0.1		A10200 H	09/22/19 02:16 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 09:00
Lab ID:	H19080446-004	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ1-4	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	127.1	mg/m2		0.1		A10200 H	09/22/19 02:45 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 09:00
Lab ID:	H19080446-005	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ1-5	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	129.5	mg/m2		0.1		A10200 H	09/22/19 03:13 / stp

Report Definitions:	RL - Analyte reporting limit. QCL - Quality control limit.	MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 11:00
Lab ID:	H19080446-006	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ2-1	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	132.5	mg/m2		0.1		A10200 H	09/22/19 03:41 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Stag Benthics
Project: Tintina Resources
Lab ID: H19080446-007
Client Sample ID: Sheep Creek AQ2-2

Report Date: 09/25/19
Collection Date: 08/13/19 11:00
DateReceived: 08/13/19
Matrix: Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	176.5	mg/m2		0.1		A10200 H	09/22/19 06:29 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 11:00
Lab ID:	H19080446-008	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ2-3	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	115.0	mg/m2		0.1		A10200 H	09/22/19 06:57 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 11:00
Lab ID:	H19080446-009	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ2-4	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	151.9	mg/m2		0.1		A10200 H	09/22/19 07:26 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 11:00
Lab ID:	H19080446-010	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ2-5	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	235.7	mg/m2		0.1		A10200 H	09/22/19 07:54 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Stag Benthics
Project: Tintina Resources
Lab ID: H19080446-011
Client Sample ID: Sheep Creek AQ3-1

Report Date: 09/25/19
Collection Date: 08/13/19 10:30
DateReceived: 08/13/19
Matrix: Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	226.4	mg/m2		0.1		A10200 H	09/22/19 08:22 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Stag Benthics
Project: Tintina Resources
Lab ID: H19080446-012
Client Sample ID: Sheep Creek AQ3-2

Report Date: 09/25/19
Collection Date: 08/13/19 10:30
DateReceived: 08/13/19
Matrix: Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	198.5	mg/m2		0.1		A10200 H	09/22/19 09:46 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics		**Report Date:**	09/25/19
Project:	Tintina Resources		**Collection Date:**	08/13/19 10:30
Lab ID:	H19080446-013		**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ3-3		**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	150.5	mg/m2		0.1		A10200 H	09/22/19 10:14 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Stag Benthics
Project: Tintina Resources
Lab ID: H19080446-014
Client Sample ID: Sheep Creek AQ3-4

Report Date: 09/25/19
Collection Date: 08/13/19 10:30
DateReceived: 08/13/19
Matrix: Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	108.3	mg/m2		0.1		A10200 H	09/22/19 10:42 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 10:30
Lab ID:	H19080446-015	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ3-5	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	121.1	mg/m2		0.1		A10200 H	09/22/19 11:10 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 10:00
Lab ID:	H19080446-016	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ4-1	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	56.2	mg/m2		0.1		A10200 H	09/22/19 12:38 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 10:00
Lab ID:	H19080446-017	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ4-2	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	50.8	mg/m2		0.1		A10200 H	09/22/19 13:06 / stp

Report Definitions:	RL - Analyte reporting limit.	MCL - Maximum contaminant level.
	QCL - Quality control limit.	ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 10:00
Lab ID:	H19080446-018	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ4-3	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	61.4	mg/m2		0.1		A10200 H	09/22/19 13:34 / stp

Report Definitions: RL - Analyte reporting limit. QCL - Quality control limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 10:00
Lab ID:	H19080446-019	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ4-4	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	60.2	mg/m2		0.1		A10200 H	09/22/19 14:02 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 10:00
Lab ID:	H19080446-020	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ4-5	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	54.1	mg/m2		0.1		A10200 H	09/22/19 14:31 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 09:30
Lab ID:	H19080446-021	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ10-1	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	57.9	mg/m2		0.1		A10200 H	09/22/19 14:59 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Stag Benthics
Project: Tintina Resources
Lab ID: H19080446-022
Client Sample ID: Sheep Creek AQ10-2

Report Date: 09/25/19
Collection Date: 08/13/19 09:30
DateReceived: 08/13/19
Matrix: Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	62.1	mg/m2		0.1		A10200 H	09/22/19 16:23 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 09:30
Lab ID:	H19080446-023	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ10-3	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	57.6	mg/m2		0.1		A10200 H	09/22/19 16:51 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 09:30
Lab ID:	H19080446-024	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ10-4	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	82.4	mg/m2		0.1		A10200 H	09/22/19 17:19 / stp

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	09/25/19
Project:	Tintina Resources	**Collection Date:**	08/13/19 09:30
Lab ID:	H19080446-025	**DateReceived:**	08/13/19
Client Sample ID:	Sheep Creek AQ10-5	**Matrix:**	Biomass

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
BIOLOGICAL							
Chlorophyll a	73.3	mg/m2		0.1		A10200 H	09/22/19 17:47 / stp

Report Definitions:	RL - Analyte reporting limit. QCL - Quality control limit.	MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: Stag Benthics **Work Order:** H19080446 **Report Date:** 09/25/19

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: A10200 H							Analytical Run: CHLOROPHYLL UV/VIS_190919A			
Lab ID: CCV_65r-W		Continuing Calibration Verification Standard							09/22/19 18:15	
Chlorophyll a		2.572	mg/m2	0.10	103	85	115			
Method: A10200 H									Batch: 47830	
Lab ID: MB-47830		Method Blank				Run: CHLOROPHYLL UV/VIS_190			09/20/19 19:14	
Chlorophyll a		ND	mg/m2	1E-06						
Lab ID: LCS-47830		Laboratory Control Sample				Run: CHLOROPHYLL UV/VIS_190			09/20/19 19:42	
Chlorophyll a		2.089	mg/m2	0.10	84	80	120			
Lab ID: H19080235-023AMS		Sample Matrix Spike				Run: CHLOROPHYLL UV/VIS_190			09/21/19 04:08	
Chlorophyll a		36.63	mg/m2	0.10	58	80	120			S
Lab ID: H19080235-023AMSD		Sample Matrix Spike Duplicate				Run: CHLOROPHYLL UV/VIS_190			09/21/19 04:36	
Chlorophyll a		36.51	mg/m2	0.10	57	80	120	0.3	20	S
Lab ID: H19080235-013AMS		Sample Matrix Spike				Run: CHLOROPHYLL UV/VIS_190			09/21/19 21:35	
Chlorophyll a		294.4	mg/m2	0.10	77	80	120			S
Lab ID: H19080235-013AMSD		Sample Matrix Spike Duplicate				Run: CHLOROPHYLL UV/VIS_190			09/21/19 22:04	
Chlorophyll a		299.4	mg/m2	0.10	79	80	120	1.7	20	S
Method: A10200 H									Batch: 47883	
Lab ID: MB-47883		Method Blank				Run: CHLOROPHYLL UV/VIS_190			09/22/19 05:33	
Chlorophyll a		ND	mg/m2	1E-06						
Lab ID: LCS-47883		Laboratory Control Sample				Run: CHLOROPHYLL UV/VIS_190			09/22/19 06:01	
Chlorophyll a		2.347	mg/m2	0.10	94	80	120			
Lab ID: H19080446-011AMS		Sample Matrix Spike				Run: CHLOROPHYLL UV/VIS_190			09/22/19 08:50	
Chlorophyll a		262.8	mg/m2	0.10		80	120			A
Lab ID: H19080446-011AMSD		Sample Matrix Spike Duplicate				Run: CHLOROPHYLL UV/VIS_190			09/22/19 09:18	
Chlorophyll a		268.0	mg/m2	0.10		80	120	1.9	20	A
Lab ID: H19080446-021AMS		Sample Matrix Spike				Run: CHLOROPHYLL UV/VIS_190			09/22/19 15:27	
Chlorophyll a		122.4	mg/m2	0.10	77	80	120			S
Lab ID: H19080446-021AMSD		Sample Matrix Spike Duplicate				Run: CHLOROPHYLL UV/VIS_190			09/22/19 15:55	
Chlorophyll a		119.9	mg/m2	0.10	74	80	120	2.1	20	S

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

S - Spike recovery outside of advisory limits.

Work Order Receipt Checklist

Stag Benthics H19080446

Login completed by:	Jessica C. Smith	Date Received:	8/13/2019
Reviewed by:	BL2000\rtooke	Received by:	RAT
Reviewed Date:	8/19/2019	Carrier name:	Hand Del

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☐	No ☑	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☐	No ☑	Not Applicable ☐
Container/Temp Blank temperature:	°C See Comments		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Contact and Corrective Action Comments:

Cooler 1 was received at 3.3 °C, Cooler 2 at 2.2 °C, and Cooler 3 at 3.0 °C. On Ice. IDs on samples include "Tinitina" and there are no collection times. Used IDs and time from COC. JCS 08/15/19

ENERGY Trust our People. Trust our Data.

Chain of Custody & Analytical Request Record

www.energylab.com

Page 1 of 1

Account Information (Billing information)

Company/Name	Stag Benthics
Contact	David Stagliano
Phone	406-449-6458
Mailing Address	1901 Peosta Ave
City, State, Zip	Helena, MT 59601
Email	dstagliano88@gmail.com
Receive Invoice	☐Hard Copy ☒Email
Receive Report	☐Hard Copy ☐Email
Purchase Order	
Quote	
Bottle Order	

Report Information (if different than Account Information)

Company/Name	
Contact	
Phone	
Mailing Address	
City, State, Zip	
Email	
Receive Report	☐Hard Copy ☐Email

Special Report/Formats: ☐ LEVEL IV ☐ NELAC ☐ EDD/EDT (contact laboratory) ☐ Other______

Comments

C1 3.3
C2 2.2
C3 3.0

Project Information

Project Name, PWSID, Permit, etc.	Tintina Resources
Sampler Name	D. Stagliano
Sampler Phone	Same as above
Sample Origin State	MT
EPA/State Compliance	☐ Yes ☐ No

MINING CLIENTS, please indicate sample type.
*If ore has been processed or refined, call before sending.
☐ Byproduct 11 (e)2 material ☐ Unprocessed ore (NOT ground or refined)*

Matrix Codes
A - Air
W - Water
S - Soils/ Solids
V - Vegetation
B - Bioassay
O - Other
DW - Drinking Water

Analysis Requested

All turnaround times are standard unless marked as RUSH.
Energy Laboratories MUST be contacted prior to RUSH sample submittal for charges and scheduling – See Instructions Page

	Sample Identification (Name, Location, Interval, etc.)	Collection Date	Collection Time	Number of Containers	Matrix (See Codes Above)	CHLA (Chlorophyll A)	See Attached	RUSH TAT	ELI LAB ID Laboratory Use Only
C1 1	Sheep Creek AQ1	8/13/19	9:00am	5					H19080446
C3 2	Sheep Creek AQ2	8/13/19	11:00am	5					
C2 3	Sheep Creek AQ3	8/13/19	10:30am	5					
C3 4	Sheep Creek AQ4	8/13/19	10:00am	5					
C1 5	Sheep Creek AQ10	8/13/19	9:30	5					
6									
7									
8									
9									
10									

Custody Record MUST be signed			
Relinquished by (print): David Stagliano	Date/Time: 8/13/19 12:48	Signature: [signature]	
Relinquished by (print)	Date/Time	Signature	
Received by (print)	Date/Time	Signature	
Received by Laboratory (print): Rebecca Tode	Date/Time: 8/13/19 12:48	Signature: [signature]	

LABORATORY USE ONLY

Shipped By	Cooler ID(s)	Custody Seals	Intact	Receipt Temp	Temp Blank	On Ice	Payment Type	Amount	Receipt Number (cash/check only)
hand	3	Y (N) C B	Y N	see com °C	Y (N)	(Y) N	CC Cash Check___	$	

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All subcontracted data will be clearly notated on your analytical report.

ELI-COC-12/16 v.1

Appendix F

Fish Tissue Analysis Report

ANALYTICAL SUMMARY REPORT

July 29, 2019

Stag Benthics
1901 Peosta Ave
Helena, MT 59601-1625

Work Order: H19070359

Project Name: Tintina Resources

Energy Laboratories Inc Helena MT received the following 5 samples for Stag Benthics on 7/17/2019 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H19070359-001	Little Sheep Creek AQ7	07/16/19 8:00	07/17/19	Fish	Metals by ICP/ICPMS, Total Composite Fee Mercury in Solid By CVAA Moisture Total Metals Digestion by SW3050B Mercury Digestion by SW7471B Soil Preparation USDA1
H19070359-002	Moose Creek MO.1	07/16/19 10:00	07/17/19	Fish	Metals by ICP/ICPMS, Total Composite Fee Mercury in Solid By CVAA Moisture Total Metals Digestion by SW3050B Mercury Digestion by SW7471B
H19070359-003	Sheep Creek AQ1	07/16/19 12:00	07/17/19	Fish	Same As Above
H19070359-004	Sheep Creek AQ2	07/16/19 15:00	07/17/19	Fish	Same As Above
H19070359-005	Sheep Creek AQ4	07/16/19 9:00	07/17/19	Fish	Same As Above

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative. Any issues encountered during sample receipt are documented in the Work Order Receipt Checklist.

The results as reported relate only to the item(s) submitted for testing. This report shall be used or copied only in its entirety. Energy Laboratories, Inc. is not responsible for the consequences arising from the use of a partial report.

If you have any questions regarding these test results, please contact your Project Manager.

Report Approved By:

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Stag Benthics
Project: Tintina Resources
Lab ID: H19070359-001
Client Sample ID: Little Sheep Creek AQ7

Report Date: 07/29/19
Collection Date: 07/16/19 08:00
DateReceived: 07/17/19
Matrix: Fish

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL CHARACTERISTICS							
Moisture (As Received)	77.7	wt%		0.2		D2974	07/22/19 09:33 / ber
3050 EXTRACTABLE METALS							
Aluminum	42	mg/kg	D	8		SW6020	07/26/19 14:58 / dck
Arsenic	ND	mg/kg		1		SW6020	07/26/19 14:58 / dck
Cadmium	ND	mg/kg		1		SW6010B	07/27/19 13:41 / sld
Copper	ND	mg/kg		1		SW6020	07/26/19 14:58 / dck
Lead	ND	mg/kg		1		SW6020	07/26/19 14:58 / dck
Manganese	5	mg/kg		1		SW6020	07/26/19 14:58 / dck
Selenium	2	mg/kg		1		SW6020	07/26/19 14:58 / dck
Zinc	21	mg/kg	D	6		SW6020	07/26/19 14:58 / dck
METALS, TOTAL							
Mercury	ND	mg/kg		0.50		SW7471B	07/23/19 13:37 / ber

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	07/29/19
Project:	Tintina Resources	**Collection Date:**	07/16/19 10:00
Lab ID:	H19070359-002	**DateReceived:**	07/17/19
Client Sample ID:	Moose Creek MO.1	**Matrix:**	Fish

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL CHARACTERISTICS							
Moisture (As Received)	83.5	wt%		0.2		D2974	07/22/19 09:33 / ber
3050 EXTRACTABLE METALS							
Aluminum	40	mg/kg	D	8		SW6020	07/26/19 15:03 / dck
Arsenic	ND	mg/kg		1		SW6020	07/26/19 15:03 / dck
Cadmium	ND	mg/kg		1		SW6010B	07/27/19 14:07 / sld
Copper	ND	mg/kg		1		SW6020	07/26/19 15:03 / dck
Lead	ND	mg/kg		1		SW6020	07/26/19 15:03 / dck
Manganese	5	mg/kg		1		SW6020	07/26/19 15:03 / dck
Selenium	ND	mg/kg		1		SW6020	07/26/19 15:03 / dck
Zinc	18	mg/kg	D	6		SW6020	07/26/19 15:03 / dck
METALS, TOTAL							
Mercury	ND	mg/kg		0.50		SW7471B	07/23/19 13:49 / ber

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Stag Benthics
Project: Tintina Resources
Lab ID: H19070359-003
Client Sample ID: Sheep Creek AQ1

Report Date: 07/29/19
Collection Date: 07/16/19 12:00
DateReceived: 07/17/19
Matrix: Fish

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL CHARACTERISTICS							
Moisture (As Received)	80.4	wt%		0.2		D2974	07/22/19 09:33 / ber
3050 EXTRACTABLE METALS							
Aluminum	28	mg/kg	D	8		SW6020	07/26/19 15:06 / dck
Arsenic	ND	mg/kg		1		SW6020	07/26/19 15:06 / dck
Cadmium	ND	mg/kg		1		SW6010B	07/27/19 14:11 / sld
Copper	ND	mg/kg		1		SW6020	07/26/19 15:06 / dck
Lead	ND	mg/kg		1		SW6020	07/26/19 15:06 / dck
Manganese	8	mg/kg		1		SW6020	07/26/19 15:06 / dck
Selenium	ND	mg/kg		1		SW6020	07/26/19 15:06 / dck
Zinc	22	mg/kg	D	6		SW6020	07/26/19 15:06 / dck
METALS, TOTAL							
Mercury	ND	mg/kg		0.50		SW7471B	07/23/19 13:52 / ber

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	07/29/19
Project:	Tintina Resources	**Collection Date:**	07/16/19 15:00
Lab ID:	H19070359-004	**DateReceived:**	07/17/19
Client Sample ID:	Sheep Creek AQ2	**Matrix:**	Fish

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL CHARACTERISTICS							
Moisture (As Received)	86.0	wt%		0.2		D2974	07/22/19 09:33 / ber
3050 EXTRACTABLE METALS							
Aluminum	46	mg/kg	D	8		SW6020	07/26/19 15:09 / dck
Arsenic	ND	mg/kg		1		SW6020	07/26/19 15:09 / dck
Cadmium	ND	mg/kg		1		SW6010B	07/27/19 14:15 / sld
Copper	ND	mg/kg		1		SW6020	07/26/19 15:09 / dck
Lead	ND	mg/kg		1		SW6020	07/26/19 15:09 / dck
Manganese	10	mg/kg		1		SW6020	07/26/19 15:09 / dck
Selenium	ND	mg/kg		1		SW6020	07/26/19 15:09 / dck
Zinc	22	mg/kg	D	6		SW6020	07/26/19 15:09 / dck
METALS, TOTAL							
Mercury	ND	mg/kg		0.50		SW7471B	07/23/19 13:54 / ber

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	07/29/19
Project:	Tintina Resources	**Collection Date:**	07/16/19 09:00
Lab ID:	H19070359-005	**DateReceived:**	07/17/19
Client Sample ID:	Sheep Creek AQ4	**Matrix:**	Fish

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL CHARACTERISTICS							
Moisture (As Received)	85.8	wt%		0.2		D2974	07/22/19 09:33 / ber
3050 EXTRACTABLE METALS							
Aluminum	13	mg/kg	D	8		SW6020	07/26/19 15:12 / dck
Arsenic	ND	mg/kg		1		SW6020	07/26/19 15:12 / dck
Cadmium	ND	mg/kg		1		SW6010B	07/27/19 14:19 / sld
Copper	ND	mg/kg		1		SW6020	07/26/19 15:12 / dck
Lead	ND	mg/kg		1		SW6020	07/26/19 15:12 / dck
Manganese	4	mg/kg		1		SW6020	07/26/19 15:12 / dck
Selenium	ND	mg/kg		1		SW6020	07/26/19 15:12 / dck
Zinc	13	mg/kg	D	6		SW6020	07/26/19 15:12 / dck
METALS, TOTAL							
Mercury	ND	mg/kg		0.50		SW7471B	07/23/19 13:56 / ber

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: Stag Benthics **Work Order:** H19070359 **Report Date:** 07/29/19

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: **D2974**										Batch: R146087
Lab ID: **H19070359-003ADUP**		Sample Duplicate				Run: SOIL DRYING OVEN 2_19071				07/22/19 09:33
Moisture (As Received)		82.3	wt%	0.20				2.4	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: Stag Benthics **Work Order:** H19070359 **Report Date:** 07/29/19

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: **SW6010B**										Analytical Run: ICP2-HE_190726A
Lab ID: **ICV**		Initial Calibration Verification Standard								07/26/19 09:19
Cadmium		0.396	mg/L	0.010	99	90	110			
Lab ID: **ICSA**		Interference Check Sample A								07/26/19 09:34
Cadmium		0.00123	mg/L	0.010		0	0			
Lab ID: **ICSAB**		Interference Check Sample AB								07/26/19 09:38
Cadmium		0.920	mg/L	0.010	92	80	120			
Method: **SW6010B**										Batch: 46705
Lab ID: **MB-46705**		Method Blank				Run: ICP2-HE_190726A				07/27/19 13:29
Cadmium		ND	mg/kg	0.03						
Lab ID: **LFB-46705**		Laboratory Fortified Blank				Run: ICP2-HE_190726A				07/27/19 13:33
Cadmium		23.8	mg/kg	1.0	94	80	120			
Lab ID: **LCS-46705**		Laboratory Control Sample				Run: ICP2-HE_190726A				07/27/19 13:37
Cadmium		82.0	mg/kg	1.0	83	73.9	106.1			
Lab ID: **H19070359-001ADIL**		Serial Dilution				Run: ICP2-HE_190726A				07/27/19 13:44
Cadmium		ND	mg/kg	1.0		0	0		10	
Lab ID: **H19070359-001APDS**		Post Digestion/Distillation Spike				Run: ICP2-HE_190726A				07/27/19 13:48
Cadmium		46.0	mg/kg	1.0	88	75	125			
Lab ID: **H19070359-001AMS**		Sample Matrix Spike				Run: ICP2-HE_190726A				07/27/19 14:00
Cadmium		22.8	mg/kg	1.0	89	75	125			
Lab ID: **H19070359-001AMSD**		Sample Matrix Spike Duplicate				Run: ICP2-HE_190726A				07/27/19 14:03
Cadmium		23.0	mg/kg	1.0	91	75	125	0.8	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: Stag Benthics **Work Order:** H19070359 **Report Date:** 07/29/19

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6020										Analytical Run: ICPMS205-H_190725B
Lab ID: ICV	7	Initial Calibration Verification Standard								07/26/19 12:24
Aluminum		0.291	mg/L	0.0022	97	90	110			
Arsenic		0.0621	mg/L	0.0010	104	90	110			
Copper		0.0626	mg/L	0.0010	104	90	110			
Lead		0.0620	mg/L	0.0010	103	90	110			
Manganese		0.312	mg/L	0.0010	104	90	110			
Selenium		0.0560	mg/L	0.0010	93	90	110			
Zinc		0.0632	mg/L	0.0022	105	90	110			
Lab ID: ICSA	7	Interference Check Sample A								07/26/19 12:27
Aluminum		39.4	mg/L	0.0022	98	70	130			
Arsenic		1.28E-05	mg/L	0.0010						
Copper		9.74E-05	mg/L	0.0010						
Lead		9.62E-05	mg/L	0.0010						
Manganese		0.000268	mg/L	0.0010		0	0			
Selenium		7.45E-05	mg/L	0.0010						
Zinc		0.000269	mg/L	0.0022						
Lab ID: ICSAB	7	Interference Check Sample AB								07/26/19 12:30
Aluminum		39.4	mg/L	0.0022	99	70	130			
Arsenic		0.0102	mg/L	0.0010	102	70	130			
Copper		0.0194	mg/L	0.0010	97	70	130			
Lead		9.90E-05	mg/L	0.0010		0	0			
Manganese		0.0205	mg/L	0.0010	102	70	130			
Selenium		0.00926	mg/L	0.0010	93	70	130			
Zinc		0.0101	mg/L	0.0022	101	70	130			
Method: SW6020										Batch: 46705
Lab ID: MB-46705	7	Method Blank				Run: ICPMS205-H_190725B				07/26/19 14:46
Aluminum		ND	mg/kg	8						
Arsenic		ND	mg/kg	0.09						
Copper		ND	mg/kg	0.8						
Lead		ND	mg/kg	0.2						
Manganese		ND	mg/kg	1						
Selenium		ND	mg/kg	0.2						
Zinc		ND	mg/kg	6						
Lab ID: LCS-46705	7	Laboratory Control Sample				Run: ICPMS205-H_190725B				07/26/19 14:49
Aluminum		8630	mg/kg	7.9	88	46.3	130.2			
Arsenic		177	mg/kg	1.0	90	71.4	105.1			
Copper		130	mg/kg	1.0	95	76.6	108.8			
Lead		112	mg/kg	1.0	106	74.4	108.6			
Manganese		451	mg/kg	1.4	104	81.1	116.6			
Selenium		188	mg/kg	1.0	92	71.2	110.2			
Zinc		250	mg/kg	6.2	108	75.3	111.7			
Lab ID: H19070359-001ADIL	7	Serial Dilution				Run: ICPMS205-H_190725B				07/26/19 15:01
Aluminum		43.8	mg/kg	39		0	0		10	N

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

N - The analyte concentration was not sufficiently high to calculate a RPD for the serial dilution test.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: Stag Benthics **Work Order:** H19070359 **Report Date:** 07/29/19

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6020									Batch: 46705	
Lab ID: H19070359-001ADIL	7	Serial Dilution				Run: ICPMS205-H_190725B			07/26/19 15:01	
Arsenic		ND	mg/kg	1.0		0	0		10	
Copper		ND	mg/kg	4.0		0	0		10	
Lead		ND	mg/kg	1.0		0	0		10	
Manganese		ND	mg/kg	7.0		0	0		10	
Selenium		1.93	mg/kg	1.0		0	0		10	N
Zinc		ND	mg/kg	31		0	0		10	
Lab ID: LFB-46705	7	Laboratory Fortified Blank				Run: ICPMS205-H_190725B			07/26/19 15:15	
Aluminum		248	mg/kg	7.9	98	80	120			
Arsenic		52.4	mg/kg	1.0	104	80	120			
Copper		54.1	mg/kg	1.0	107	80	120			
Lead		55.2	mg/kg	1.0	109	80	120			
Manganese		263	mg/kg	1.4	104	80	120			
Selenium		47.0	mg/kg	1.0	93	80	120			
Zinc		53.0	mg/kg	6.1	105	80	120			
Lab ID: H19070359-001APDS1	7	Post Digestion/Distillation Spike				Run: ICPMS205-H_190725B			07/26/19 15:18	
Aluminum		54.0	mg/kg	7.9	94	75	125			
Arsenic		12.7	mg/kg	1.0	100	75	125			
Copper		13.8	mg/kg	1.0	102	75	125			
Lead		12.6	mg/kg	1.0	100	75	125			
Manganese		17.5	mg/kg	1.4	98	75	125			
Selenium		13.2	mg/kg	1.0	90	75	125			
Zinc		34.3	mg/kg	6.1	104	75	125			
Lab ID: H19070359-001AMS	7	Sample Matrix Spike				Run: ICPMS205-H_190725B			07/26/19 15:21	
Aluminum		325	mg/kg	7.9	111	75	125			
Arsenic		50.3	mg/kg	1.0	98	75	125			
Copper		52.8	mg/kg	1.0	102	75	125			
Lead		52.3	mg/kg	1.0	103	75	125			
Manganese		258	mg/kg	1.4	99	75	125			
Selenium		47.4	mg/kg	1.0	90	75	125			
Zinc		70.5	mg/kg	6.1	97	75	125			
Lab ID: H19070359-001AMSD	7	Sample Matrix Spike Duplicate				Run: ICPMS205-H_190725B			07/26/19 15:24	
Aluminum		321	mg/kg	7.9	111	75	125	1.3	20	
Arsenic		49.4	mg/kg	1.0	98	75	125	2.0	20	
Copper		52.2	mg/kg	1.0	102	75	125	1.1	20	
Lead		52.1	mg/kg	1.0	103	75	125	0.4	20	
Manganese		257	mg/kg	1.4	100	75	125	0.4	20	
Selenium		46.3	mg/kg	1.0	88	75	125	2.3	20	
Zinc		71.5	mg/kg	6.1	100	75	125	1.4	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

N - The analyte concentration was not sufficiently high to calculate a RPD for the serial dilution test.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: Stag Benthics **Work Order:** H19070359 **Report Date:** 07/29/19

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW7471B									Analytical Run: HGCV203-H_190723A	
Lab ID: ICV		Initial Calibration Verification Standard							07/23/19 13:10	
Mercury		0.0010	mg/kg	0.50	101	90	110			
Lab ID: CCV		Continuing Calibration Verification Standard							07/23/19 13:12	
Mercury		0.0024	mg/kg	0.50	98	90	110			
Lab ID: CCV		Continuing Calibration Verification Standard							07/23/19 13:43	
Mercury		0.0024	mg/kg	0.50	97	90	110			
Lab ID: ICV		Initial Calibration Verification Standard							07/24/19 10:03	
Mercury		0.00099	mg/kg	0.50	99	90	110			
Method: SW7471B									Batch: 46666	
Lab ID: MB-46666		Method Blank				Run: HGCV203-H_190723A			07/23/19 13:18	
Mercury		ND	mg/kg	0.003						
Lab ID: LCS-46666		Laboratory Control Sample				Run: HGCV203-H_190723A			07/23/19 13:20	
Mercury		5.0	mg/kg	0.50	99	71	126.4			
Lab ID: LFB-46666		Laboratory Fortified Blank				Run: HGCV203-H_190723A			07/23/19 13:22	
Mercury		0.20	mg/kg	0.50	100	80	120			
Lab ID: H19070359-001AMS		Sample Matrix Spike				Run: HGCV203-H_190723A			07/23/19 13:41	
Mercury		0.19	mg/kg	0.50	86	80	120			
Lab ID: H19070359-001AMSD		Sample Matrix Spike Duplicate				Run: HGCV203-H_190723A			07/23/19 13:47	
Mercury		0.16	mg/kg	0.50	68	80	120	20	20	S

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

S - Spike recovery outside of advisory limits.

Work Order Receipt Checklist

Stag Benthics H19070359

Login completed by: Jessica C. Smith
Reviewed by: BL2000\rtooke
Reviewed Date: 7/19/2019

Date Received: 7/17/2019
Received by: RAT
Carrier name: Hand Del

Shipping container/cooler in good condition?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☐	No ☑	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☑	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☐	No ☑	Not Applicable ☐
Container/Temp Blank temperature:	1.2°C No Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☑

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Contact and Corrective Action Comments:

IDs on samples are Little Sheeq AQ7, Sheep AQ1, Sheep AQ2 and Sheep AQ4. Used IDs from COC. JCS 07/17/19

ANALYTICAL SUMMARY REPORT

August 08, 2019

Stag Benthics
1901 Peosta Ave
Helena, MT 59601-1625

Work Order: H19070582

Project Name: Tintina Resources

Energy Laboratories Inc Helena MT received the following 1 sample for Stag Benthics on 7/26/2019 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H19070582-001	Sheep Creek AQ10	07/25/19 12:00	07/26/19	Fish	Metals by ICP/ICPMS, Total Composite Fee Mercury in Solid By CVAA Moisture Total Metals Digestion by SW3050B Mercury Digestion by SW7471B Soil Preparation USDA1

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative. Any issues encountered during sample receipt are documented in the Work Order Receipt Checklist.

The results as reported relate only to the item(s) submitted for testing. This report shall be used or copied only in its entirety. Energy Laboratories, Inc. is not responsible for the consequences arising from the use of a partial report.

If you have any questions regarding these test results, please contact your Project Manager.

Report Approved By:

LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client:	Stag Benthics	**Report Date:**	08/08/19
Project:	Tintina Resources	**Collection Date:**	07/25/19 12:00
Lab ID:	H19070582-001	**DateReceived:**	07/26/19
Client Sample ID:	Sheep Creek AQ10	**Matrix:**	Fish

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL CHARACTERISTICS							
Moisture (As Received)	77.6	wt%		0.2		D2974	08/05/19 08:27 / iej
3050 EXTRACTABLE METALS							
Aluminum	134	mg/kg	D	8		SW6020	08/01/19 10:10 / dck
Arsenic	ND	mg/kg		1		SW6020	08/01/19 10:10 / dck
Cadmium	ND	mg/kg		1		SW6020	08/06/19 14:59 / dck
Copper	1	mg/kg		1		SW6020	08/01/19 10:10 / dck
Lead	ND	mg/kg		1		SW6020	08/06/19 14:59 / dck
Manganese	9	mg/kg		1		SW6020	08/01/19 10:10 / dck
Selenium	ND	mg/kg		1		SW6020	08/01/19 10:10 / dck
Zinc	31	mg/kg	D	6		SW6020	08/01/19 10:10 / dck
METALS, TOTAL							
Mercury	ND	mg/kg		0.50		SW7471B	07/31/19 14:26 / ber

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
D - RL increased due to sample matrix.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: Stag Benthics **Work Order:** H19070582 **Report Date:** 08/08/19

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: D2974										Batch: R146531
Lab ID: H19070582-001ADUP		Sample Duplicate				Run: SOIL DRYING OVEN 2_19080			08/05/19 08:27	
Moisture (As Received)		77.3	wt%	0.20				0.3	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: Stag Benthics **Work Order:** H19070582 **Report Date:** 08/08/19

Method: **SW6020** Analytical Run: ICPMS205-H_190801A

Lab ID: **ICV** 6 Initial Calibration Verification Standard 08/01/19 07:52

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Aluminum		0.294	mg/L	0.0022	98	90	110			
Arsenic		0.0600	mg/L	0.0010	100	90	110			
Copper		0.0623	mg/L	0.0010	104	90	110			
Manganese		0.309	mg/L	0.0010	103	90	110			
Selenium		0.0614	mg/L	0.0010	102	90	110			
Zinc		0.0626	mg/L	0.0022	104	90	110			

Lab ID: **ICSA** 6 Interference Check Sample A 08/01/19 07:54

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Aluminum		41.4	mg/L	0.0022	104	70	130			
Arsenic		1.13E-05	mg/L	0.0010						
Copper		5.49E-05	mg/L	0.0010						
Manganese		0.000272	mg/L	0.0010		0	0			
Selenium		7.67E-05	mg/L	0.0010						
Zinc		0.000280	mg/L	0.0022						

Lab ID: **ICSAB** 6 Interference Check Sample AB 08/01/19 07:57

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Aluminum		43.9	mg/L	0.0022	110	70	130			
Arsenic		0.0110	mg/L	0.0010	109	70	130			
Copper		0.0211	mg/L	0.0010	105	70	130			
Manganese		0.0223	mg/L	0.0010	111	70	130			
Selenium		0.0103	mg/L	0.0010	103	70	130			
Zinc		0.0109	mg/L	0.0022	109	70	130			

Method: **SW6020** Batch: 46836

Lab ID: **MB-46836** 6 Method Blank Run: ICPMS205-H_190801A 08/01/19 10:01

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Aluminum		ND	mg/kg	8						
Arsenic		ND	mg/kg	0.10						
Copper		ND	mg/kg	0.8						
Manganese		ND	mg/kg	1						
Selenium		ND	mg/kg	0.2						
Zinc		ND	mg/kg	6						

Lab ID: **LCS-46836** 6 Laboratory Control Sample Run: ICPMS205-H_190801A 08/01/19 10:03

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Aluminum		10000	mg/kg	8.0	102	46.3	130.2			
Arsenic		179	mg/kg	1.0	91	71.4	105.1			
Copper		137	mg/kg	1.0	100	76.6	108.8			
Manganese		481	mg/kg	1.4	111	81.1	116.6			
Selenium		206	mg/kg	1.0	100	71.2	110.2			
Zinc		251	mg/kg	6.2	109	75.3	111.7			

Lab ID: **H19070582-001ADIL** 6 Serial Dilution Run: ICPMS205-H_190801A 08/01/19 10:12

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Aluminum		137	mg/kg	38		0	0		10	N
Arsenic		ND	mg/kg	1.0		0	0		10	
Copper		ND	mg/kg	3.9		0	0		10	
Manganese		9.46	mg/kg	6.8		0	0		10	N
Selenium		ND	mg/kg	1.0		0	0		10	
Zinc		32.7	mg/kg	30		0	0		10	N

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

N - The analyte concentration was not sufficiently high to calculate a RPD for the serial dilution test.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: Stag Benthics **Work Order:** H19070582 **Report Date:** 08/08/19

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6020										Batch: 46836
Lab ID: H19070582-001ADIL	6	Serial Dilution				Run: ICPMS205-H_190801A				08/01/19 10:12
Lab ID: LFB-46836	6	Laboratory Fortified Blank				Run: ICPMS205-H_190801A				08/01/19 10:15
Aluminum		253	mg/kg	8.0	98	80	120			
Arsenic		53.4	mg/kg	1.0	104	80	120			
Copper		55.2	mg/kg	1.0	107	80	120			
Manganese		270	mg/kg	1.4	105	80	120			
Selenium		51.0	mg/kg	1.0	99	80	120			
Zinc		52.9	mg/kg	6.2	103	80	120			
Lab ID: H19070582-001APDS1	6	Post Digestion/Distillation Spike				Run: ICPMS205-H_190801A				08/01/19 10:17
Aluminum		150	mg/kg	7.6		75	125			A
Arsenic		12.2	mg/kg	1.0	98	75	125			
Copper		13.7	mg/kg	1.0	100	75	125			
Manganese		21.7	mg/kg	1.4	103	75	125			
Selenium		11.5	mg/kg	1.0	89	75	125			
Zinc		44.8	mg/kg	5.9	115	75	125			
Lab ID: H19070582-001AMS	6	Sample Matrix Spike				Run: ICPMS205-H_190801A				08/01/19 10:19
Aluminum		287	mg/kg	7.5	63	75	125			SE
Arsenic		49.1	mg/kg	1.0	101	75	125			
Copper		52.0	mg/kg	1.0	105	75	125			
Manganese		257	mg/kg	1.3	103	75	125			E
Selenium		46.8	mg/kg	1.0	96	75	125			
Zinc		78.0	mg/kg	5.8	98	75	125			
Lab ID: H19070582-001AMSD	6	Sample Matrix Spike Duplicate				Run: ICPMS205-H_190801A				08/01/19 10:22
Aluminum		314	mg/kg	7.9	70	75	125	9.1	20	SE
Arsenic		53.0	mg/kg	1.0	103	75	125	7.6	20	
Copper		55.5	mg/kg	1.0	106	75	125	6.5	20	
Manganese		277	mg/kg	1.4	105	75	125	7.3	20	E
Selenium		49.4	mg/kg	1.0	96	75	125	5.6	20	
Zinc		81.7	mg/kg	6.2	100	75	125	4.6	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

A - The analyte level was greater than four times the spike level. In accordance with the method % recovery is not calculated.

E - Estimated value. Result exceeds the instrument upper quantitation limit.

QA/QC Summary Report

Prepared by Helena, MT Branch

Client: Stag Benthics **Work Order:** H19070582 **Report Date:** 08/08/19

Analyte		Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**SW6020**							Analytical Run: ICPMS205-H_190806B			
Lab ID:	**ICV**	2	Initial Calibration Verification Standard							08/06/19 11:40	
Cadmium			0.0309	mg/L	0.0010	103	90	110			
Lead			0.0609	mg/L	0.0010	102	90	110			
Lab ID:	**ICSA**	2	Interference Check Sample A							08/06/19 11:43	
Cadmium			0.000111	mg/L	0.0010						
Lead			8.09E-05	mg/L	0.0010						
Lab ID:	**ICSAB**	2	Interference Check Sample AB							08/06/19 11:45	
Cadmium			0.0105	mg/L	0.0010	105	70	130			
Lead			6.00E-05	mg/L	0.0010		0	0			
Method:	**SW6020**									Batch: 46937	
Lab ID:	**MB-46937**	2	Method Blank				Run: ICPMS205-H_190806B			08/06/19 14:48	
Cadmium			ND	mg/kg	0.04						
Lead			ND	mg/kg	0.2						
Lab ID:	**LFB-46937**	2	Laboratory Fortified Blank				Run: ICPMS205-H_190806B			08/06/19 14:50	
Cadmium			27.2	mg/kg	1.0	107	80	120			
Lead			53.9	mg/kg	1.0	106	80	120			
Lab ID:	**LCS-46937**	2	Laboratory Control Sample				Run: ICPMS205-H_190806B			08/06/19 14:52	
Cadmium			99.2	mg/kg	1.0	100	73.9	106.1			
Lead			108	mg/kg	1.0	103	74.4	108.6			
Lab ID:	**H19070582-001ADIL**	2	Serial Dilution				Run: ICPMS205-H_190806B			08/06/19 15:01	
Cadmium			ND	mg/kg	1.0		0	0		10	
Lead			ND	mg/kg	1.0		0	0		10	
Lab ID:	**H19070582-001APDS1**	2	Post Digestion/Distillation Spike				Run: ICPMS205-H_190806B			08/06/19 18:33	
Cadmium			12.4	mg/kg	1.0	103	75	125			
Lead			11.8	mg/kg	1.0	95	75	125			
Lab ID:	**H19070582-001AMS**	2	Sample Matrix Spike				Run: ICPMS205-H_190806B			08/06/19 18:35	
Cadmium			28.3	mg/kg	1.0	110	75	125			
Lead			55.7	mg/kg	1.0	107	75	125			
Lab ID:	**H19070582-001AMSD**	2	Sample Matrix Spike Duplicate				Run: ICPMS205-H_190806B			08/06/19 18:38	
Cadmium			26.4	mg/kg	1.0	103	75	125	6.9	20	
Lead			51.7	mg/kg	1.0	101	75	125	7.5	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

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QA/QC Summary Report

Prepared by Helena, MT Branch

Client: Stag Benthics **Work Order:** H19070582 **Report Date:** 08/08/19

Analyte		Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	**SW7471B**							Analytical Run: HGCV202-H_190731B			
Lab ID:	**ICV**		Initial Calibration Verification Standard							07/31/19 13:52	
Mercury			0.0010	mg/kg	0.50	101	90	110			
Lab ID:	**CCV**		Continuing Calibration Verification Standard							07/31/19 13:59	
Mercury			0.0025	mg/kg	0.50	100	90	110			
Method:	**SW7471B**									Batch: 46874	
Lab ID:	**MB-46874**		Method Blank				Run: HGCV202-H_190731B			07/31/19 14:04	
Mercury			ND	mg/kg	0.004						
Lab ID:	**LCS-46874**		Laboratory Control Sample				Run: HGCV202-H_190731B			07/31/19 14:06	
Mercury			5.4	mg/kg	0.50	109	71	126.4			
Lab ID:	**LFB-46874**		Laboratory Fortified Blank				Run: HGCV202-H_190731B			07/31/19 14:08	
Mercury			0.20	mg/kg	0.50	106	80	120			
Lab ID:	**H19070582-001ADIL**		Serial Dilution				Run: HGCV202-H_190731B			07/31/19 14:28	
Mercury			0.094	mg/kg	0.50		0	0	9.4	10	
Lab ID:	**H19070582-001AMS**		Sample Matrix Spike				Run: HGCV202-H_190731B			07/31/19 14:30	
Mercury			0.22	mg/kg	0.50	78	80	120			S
Lab ID:	**H19070582-001AMSD**		Sample Matrix Spike Duplicate				Run: HGCV202-H_190731B			07/31/19 14:32	
Mercury			0.21	mg/kg	0.50	73	80	120	3.7	20	S
Lab ID:	**H19070593-008BDIL**		Serial Dilution				Run: HGCV202-H_190731B			07/31/19 14:55	
Mercury			ND	mg/kg	0.50		0	0		10	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

S - Spike recovery outside of advisory limits.

Work Order Receipt Checklist

Stag Benthics H19070582

Login completed by:	Jessica C. Smith	Date Received:	7/26/2019
Reviewed by:	BL2000\rtooke	Received by:	TLL
Reviewed Date:	8/1/2019	Carrier name:	Hand Del

Shipping container/cooler in good condition?	Yes [ ]	No [ ]	Not Present [X]
Custody seals intact on all shipping container(s)/cooler(s)?	Yes [ ]	No [ ]	Not Present [X]
Custody seals intact on all sample bottles?	Yes [ ]	No [ ]	Not Present [X]
Chain of custody present?	Yes [X]	No [ ]	
Chain of custody signed when relinquished and received?	Yes [X]	No [ ]	
Chain of custody agrees with sample labels?	Yes [X]	No [ ]	
Samples in proper container/bottle?	Yes [X]	No [ ]	
Sample containers intact?	Yes [X]	No [ ]	
Sufficient sample volume for indicated test?	Yes [X]	No [ ]	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes [X]	No [ ]	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes [ ]	No [X]	Not Applicable [ ]
Container/Temp Blank temperature:	8.6°C No Ice		
Water - VOA vials have zero headspace?	Yes [ ]	No [ ]	No VOA vials submitted [X]
Water - pH acceptable upon receipt?	Yes [ ]	No [ ]	Not Applicable [X]

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Contact and Corrective Action Comments:

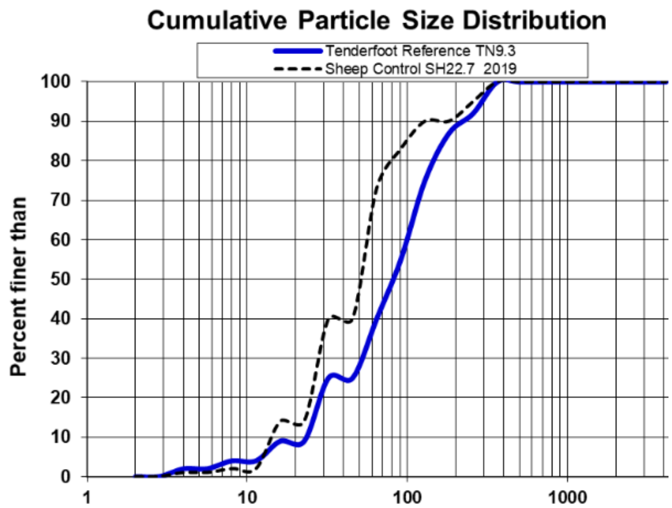
None

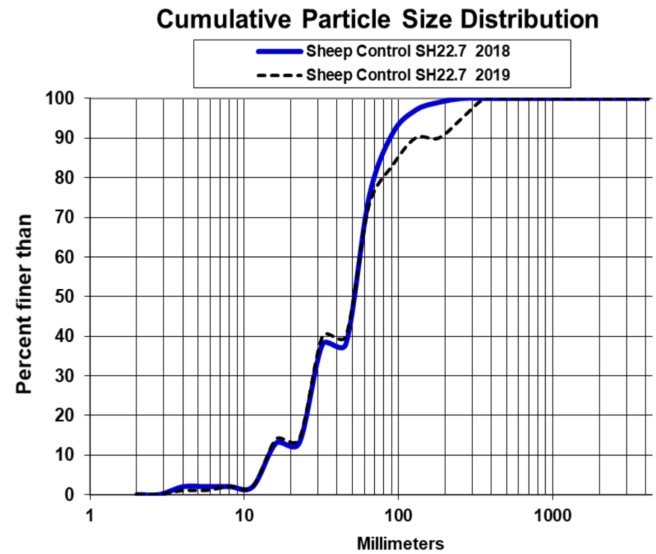
Appendix G

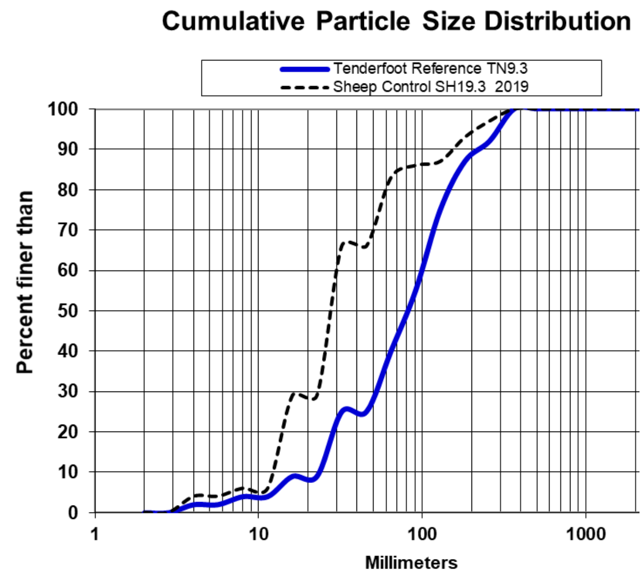
Site Habitat and Physical Conditions

Appendix H

Pebble Count Raw Data Site Graphs


Cumulative Particle Size Distribution
Tenderfoot Reference TN9.3
Sheep Control SH22.7 2019
Percent finer than
0
10
20
30
40
50
60
70
80
90
100
1
10
100
1000


Cumulative Particle Size Distribution
Sheep Control SH22.7 2018
Sheep Control SH22.7 2019
Percent finer than
0
10
20
30
40
50
60
70
80
90
100
1
10
100
1000
Millimeters


Cumulative Particle Size Distribution
Tenderfoot Reference TN9.3
Sheep Control SH19.3 2019
Percent finer than
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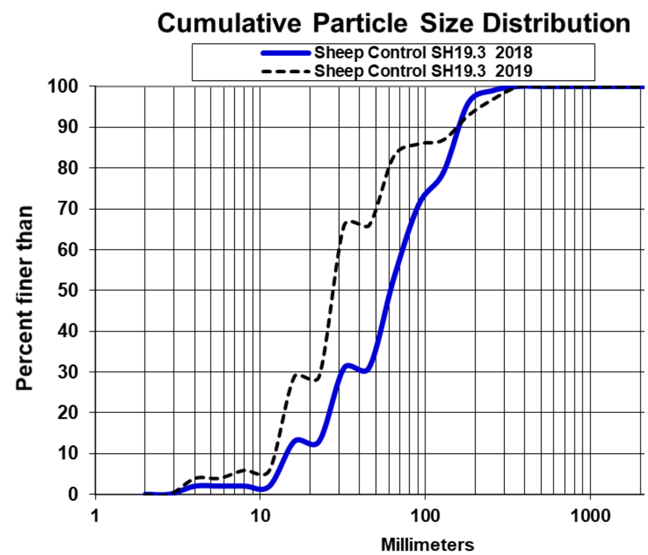
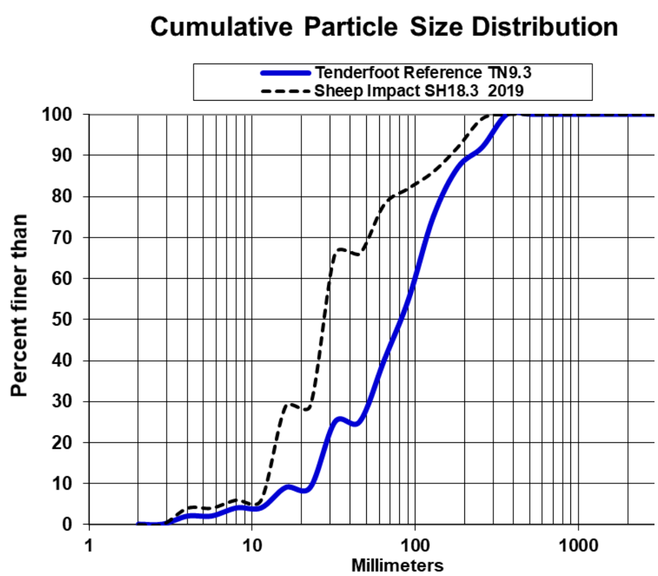
10
20
30
40
50
60
70
80
90
100
1
10
100
1000
Millimeters


Cumulative Particle Size Distribution
Sheep Control SH19.3 2018
Sheep Control SH19.3 2019
Percent finer than
0
10
20
30
40
50
60
70
80
90
100
1
10
100
1000
Millimeters


Cumulative Particle Size Distribution
Tenderfoot Reference TN9.3
Sheep Impact SH18.3 2019
Percent finer than
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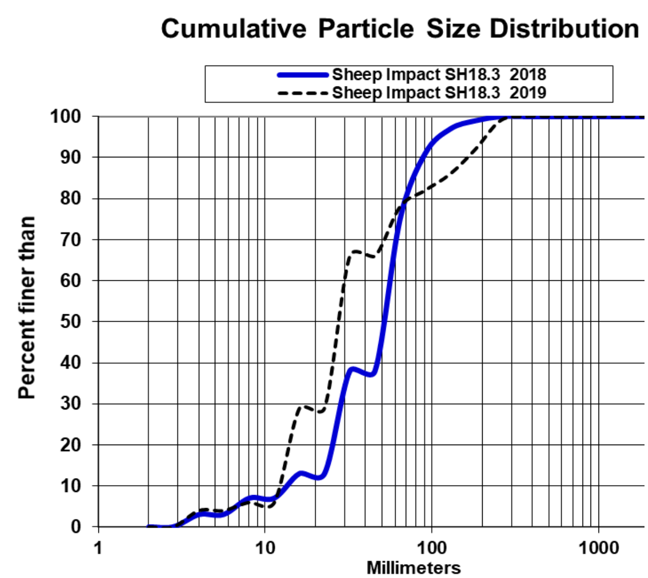
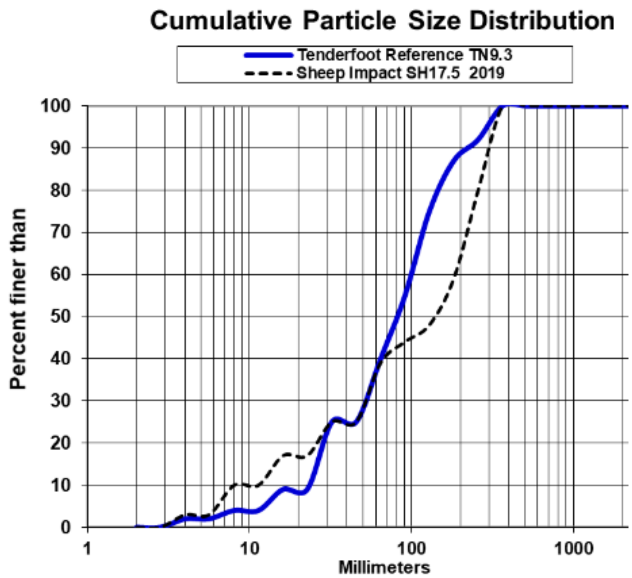
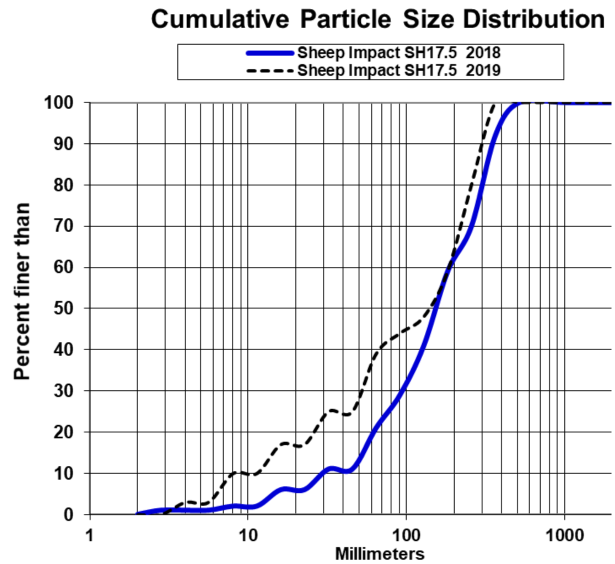
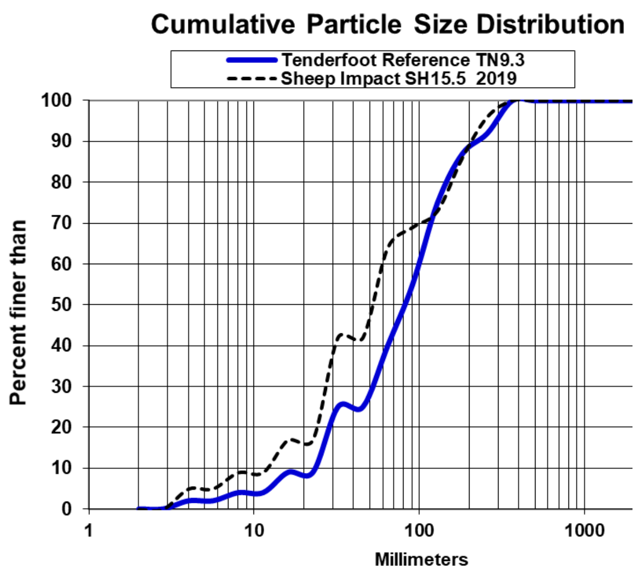
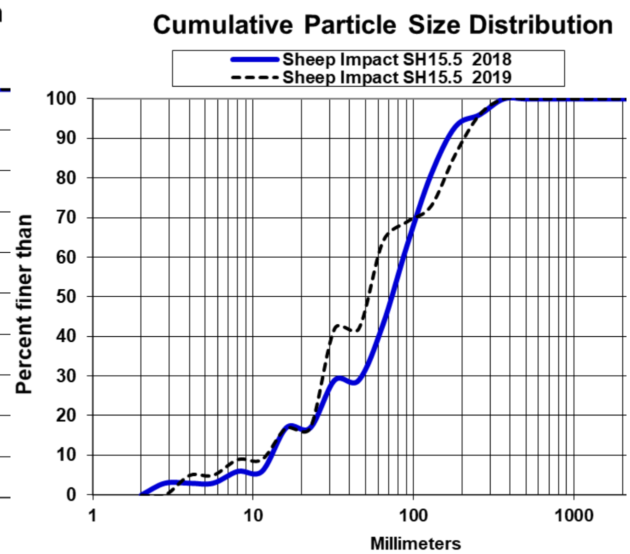
10
20
30
40
50
60
70
80
90
100
1
10
100
1000
Millimeters

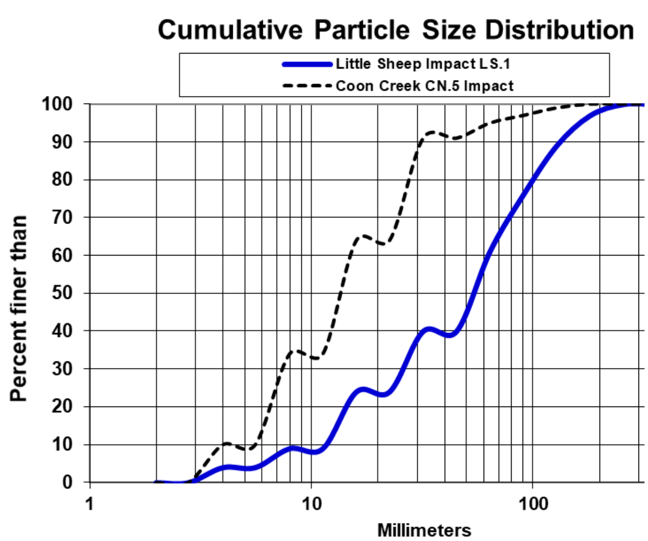

Cumulative Particle Size Distribution
Sheep Impact SH18.3 2018
Sheep Impact SH18.3 2019
Percent finer than
0
10
20
30
40
50
60
70
80
90
100
1
10
100
1000
Millimeters

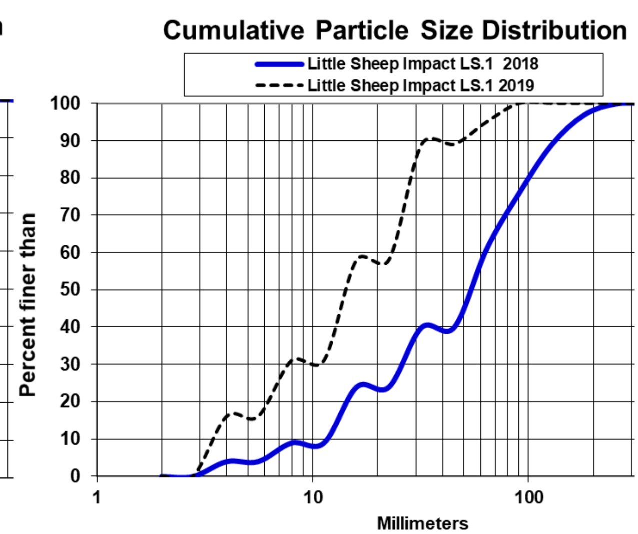

Cumulative Particle Size Distribution
Tenderfoot Reference TN9.3
Sheep Impact SH17.5 2019
Percent finer than
Millimeters

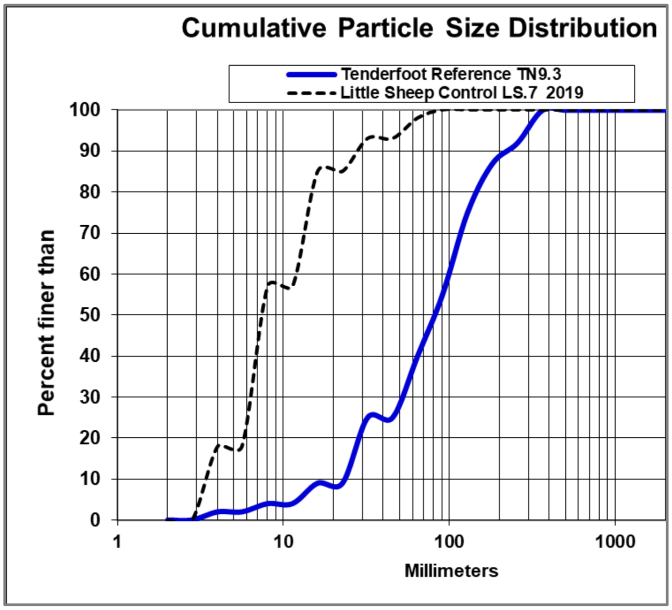

Cumulative Particle Size Distribution
Sheep Impact SH17.5 2018
Sheep Impact SH17.5 2019
Percent finer than
Millimeters

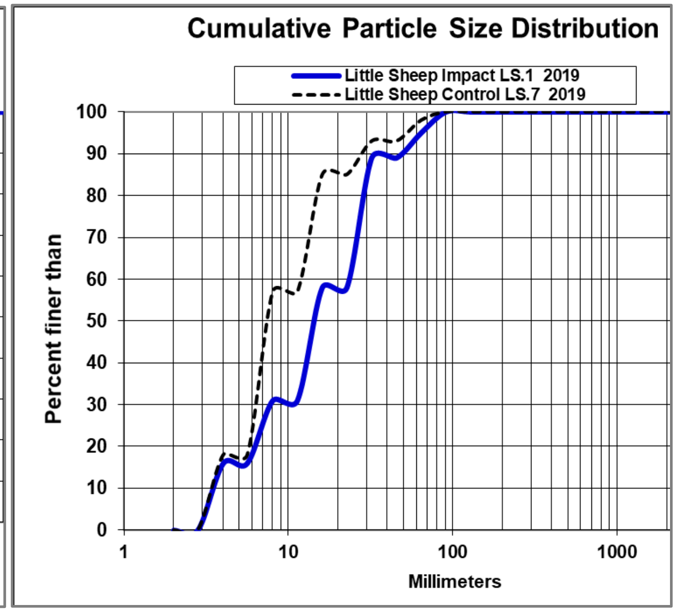

Cumulative Particle Size Distribution
Tenderfoot Reference TN9.3
Sheep Impact SH15.5 2019
Percent finer than
Millimeters

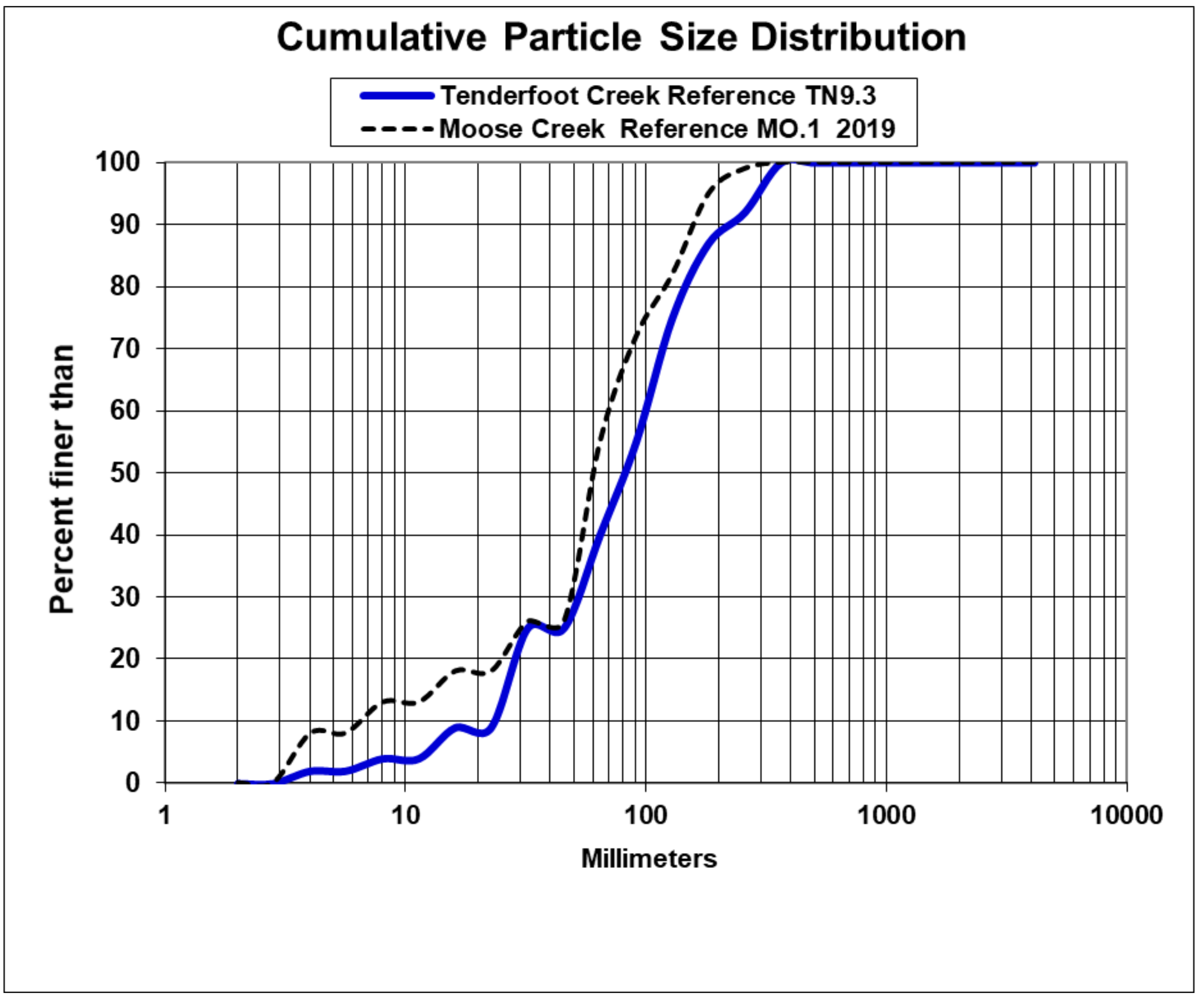

Cumulative Particle Size Distribution
Sheep Impact SH15.5 2018
Sheep Impact SH15.5 2019
Percent finer than
Millimeters


Cumulative Particle Size Distribution
Little Sheep Impact LS.1
Coon Creek CN.5 Impact
Percent finer than
Millimeters


Cumulative Particle Size Distribution
Little Sheep Impact LS.1 2018
Little Sheep Impact LS.1 2019
Percent finer than
Millimeters


Cumulative Particle Size Distribution
Tenderfoot Reference TN9.3
Little Sheep Control LS.7 2019
Percent finer than
100
90
80
70
60
50
40
30
20
10
0
1
10
100
1000
Millimeters


Cumulative Particle Size Distribution
Little Sheep Impact LS.1 2019
Little Sheep Control LS.7 2019
Percent finer than
100
90
80
70
60
50
40
30
20
10
0
1
10
100
1000
Millimeters


Cumulative Particle Size Distribution
Tenderfoot Creek Reference TN9.3
Moose Creek Reference MO.1 2019
Percent finer than
100
90
80
70
60
50
40
30
20
10
0
1
10
100
1000
10000
Millimeters

Appendix I

Redd Count Raw Data Table

Appendix I. Redd count raw data table arranged from downstream to upstream. Survey length in meters (m).

		Date of Survey	2016			2017			2018			2018				2019			2019			
			10/23	10/30		10/25	11/2		4/15	4/27	5/4	10/26	11/2	11/9		4/23	4/30	5/9	10/14	10/25	11/5	11/11
Stream	**Site ID**	**Survey Length (m)**	**Total # Redds**		**Survey Length**	**Total # Redds**		**Survey Length**	**Total # Redds**			**Total # Fall Redds**			**Survey Length**	**Total # Redds**			**Total # Fall Redds**			
Sheep AQ11	**SH15.5D**	300	0	0	400	0	0	400	na	0	LV*	0	0	AI*	500	na	0	LV*	0	0	0	Ai*
Sheep AQ10	**SH15.5U**	300	1	1	400	1	2	600	na	0	LV*	1	1	AI*	500	na	0	LV*	0	1	1	Ai*
Moose Creek	**MO.1**	600			600	4	4	600	0	1	1	2	2	2	600	na	1	2	1	1	2	2
Sheep AQ1	**SH17.5**	600	0	0	600	0	0	600	0	0	LV*	0	0	AI*	600	0	0	LV*	0	0	0	Ai*
Sheep AQ4	**SH18.2_FS**	400	2	2	300	1	1	400	0	0	LV*	2	2	AI*	300	0	0	LV*	0	1	1	Ai*
Sheep AQ4	**SH18.3**	800	22	22	800	8	8	700	0	0	LV*	12	12	AI*	800	0	0	LV*	0	6	7	Ai*
Sheep AQ3	**SH19.2**	600	19	20	600	7	7	600	0	0	LV*	8	8	AI*	600	0	0	LV*	0	6	6	Ai*
L. Sheep AQ7	**LS.1**	300	10	10	600	5	5	300	0	0	0	3	3	3	900	0	0	0	6	8	8	8
L. Sheep AQ8	**LS.7**	300	1	1	300	0	0	300	0	0	0	0	0	0	300	0	0	0	0	0	0	0
Sheep AQ2	**SH22.7**	500	6	6	800	11	11	600	0	0	LV*	7	7	AI*	600	0	0	LV*	0	6	6	Ai*

LV-low visibility of stream bottom, water cloudy from run-off

AI-anchor ice present, bottom visibility compromised

na - not accessible due to snow on roads